AIR ENGINEERING

VOL. 2, NO. 8

AUGUST, 1960

DEDICATED TO THE SCIENCE OF AIR POLLUTION CONTROL
AIR MOVING • AIR CONDITIONING

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When swamp coolers gave out, engineers designed low cost cooling system

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COVER

The close relationship of chemistry, meteorology, microscopy, air engineering, to air pollution control, is shown by this month's front cover. Cover art is by Judith A. Walters of Robert A. Taft Sanitary Engineering Center, Cincinnati.

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Letters

Editor:

In view of your editorial (page 7, June, 1960) on classroom air conditioning, you will be interested to know that this University is putting into effect the thoughts you so ably expressed.

A. Carl Messinger
University of Hartford
West Hartford, Conn.

* * *

Editor's Note:

Classrooms in this university's new General Classroom Building are fully air conditioned for year-'round use. Our editorial advocated the air conditioning of new schoolrooms, and the use of these teaching facilities on a year-'round basis, as one way to maximize both the learning ability of our youngsters and our investment in these structures.

Liked Air Sanitation Article

Editor:

I found your article "Controlling Airborne Bacteria . . . How Well Can It Be Done With Today's Air Sanitation Methods (April and May, 1960) most enlightening. I have much to learn in this field and believe that I can pick up a lot that is useful to me.

Henry A. Towle
Vienna, Va.

Editor:

We have read with interest the article, "Specifications . . . Open, Closed or Base Bid?" which appeared in the Dec., 1959 issue of AIR ENGINEERING.

W. E. Massey, Jr., Manager
Market Development
Southeastern District
Crane Co.
Atlanta, Ga.

Editor:

I would appreciate additional copies of the article by Mr. Robert H. Avery on "The Meaning of Clean Air" and the article entitled "Dust-Free Air For Gyroscopes."

My copy was given to a Colonel at Air Force Ballistic Missile Division and I need a copy for a gentleman at Space Technology Laboratories.

Ben F. Sloan
Sales and Engineering
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Downey, Calif.

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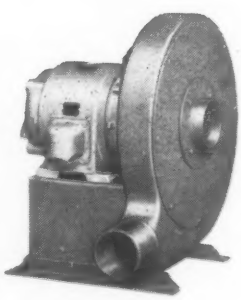

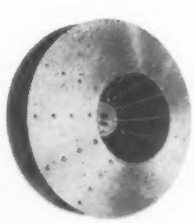

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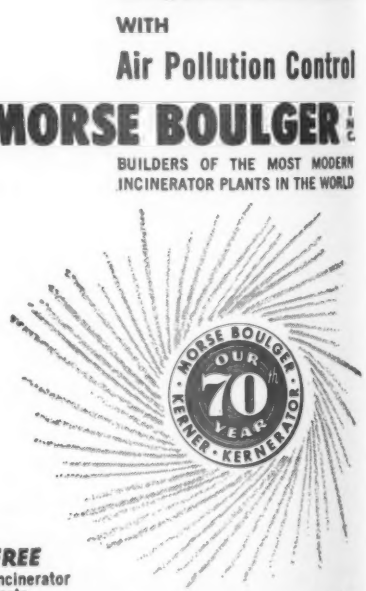

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MSA reports on:

How to Select an Air Cleaner

MSA reviews here some of the factors which influence selection of air cleaners. A speaking acquaintance with these factors can save a lot of time and money. If you would like to dwell further on any of these points, please drop us a line. We believe we can be of great help in answering questions on your specific air cleaning problems.

CLASSIFICATION OF PARTICULATE LOADS—Let's draw a parallel. Because of the heavy dust load in a sand blast booth, you would have to select a sand blast mask instead of a dust respirator. Selection of a particulate space filter is much the same proposition. You must determine the quantitative nature of the particulate load.

For this purpose, let's briefly classify particulate loads. A light load is 0.1 to 1 grain per 1000 cu. ft. A medium load is 1 to 1000 grains per 1000 cu. ft. A heavy load is 1000 grains and up per 1000 cu. ft.

One grain per 1000 cu. ft. = 2.3 mg per cubic meter = 2.3 micrograms per liter. One milligram is equivalent to 0.015432 grains. As a comparison, the concentration of the U. S. Bureau of Mines silica dust test is approximately 22 grains per 1000 cu. ft. of air.

CLASSIFICATION OF NORMAL LOAD RANGES—Country air usually registers 0.2 grains/1000 CF. Small town air ranges from 0.2 to 0.4 grains/1000 CF. City residential air ranges from 0.4 to 0.8 grains/1000 CF. City industrial air ranges from 1.0 to 2.0 grains/1000 CF. And air from industrial operations weighs in at 4.0 to 8.0 grains/1000 CF. 7000 grains, incidentally, is equal to 1 lb.

CLASSIFICATION OF PARTICULATE CLEANERS—Your actual load condition will determine which group of particulate cleaners is of immediate interest to you.

For the heavy loads: gravity separators, cyclone separators and sonic collectors.

For the medium loads: all of the above plus bag filters, impingement type box filters, and wet collectors.

For the light loads: box filters of both types and, in addition, electrostatic precipitators.

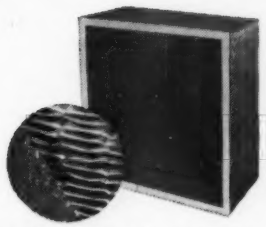
Of course, if you require ultra filtration on heavy load conditions, you should use M-S-A® UltraAire* Space Filters after the heavy duty filters.

PHYSICAL CHARACTERISTICS OF THE PARTICULATES—These characteristics affect the choice of filtering methods and/or design of the filtering system: Particle size, particle shape, specific gravity of particles, particle surface characteristics, packing or plugging characteristics, electrostatic charge on the particle, stability of the particle.

PHYSICAL CHARACTERISTICS OF THE AIR STREAM—These factors too, are worthy of investigation: Density of air, moisture in air stream, temperature of air stream, chemical and physical effect of gaseous contaminants.

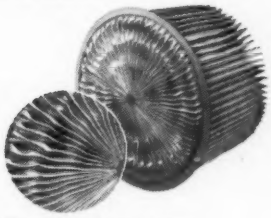
DEGREE OF FILTERING OR CLEANLINESS REQUIRED—We'd like to suggest here, that you give some thought to the toxicity or harmfulness of the particulate matter. Evaluate too, the need for cleanliness, product control, equipment maintenance, etc.

ECONOMIC FACTORS—Factors to weigh under this heading are installation costs, space requirements and operating and maintenance costs (including cost of moving air through system, replacement, etc.).



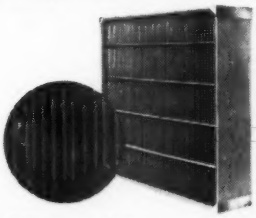
M-S-A® UltraAire* Space Filter

Lightweight, fire-resistant, unusually strong, and ideal for high humidity service. Individually pre-tested and proved at least 99.97% efficient in removing particles of 0.3 micron diameter.



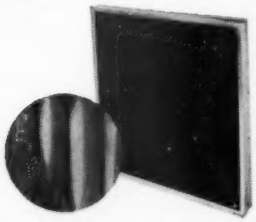
M-S-A® Cylindrical-Type UltraAire* Space Filter

Honeycomb-type fold without separators is admirably suited to cylindrical element construction. This shape is preferred for pressure systems and round ducts. Easy to handle. Inexpensive to ship.



M-S-A® Dustfoe* Space Filter

Offers the efficiency of an Electrostatic Precipitator without the high cost and without the possibility of arcing "blow-off." 85-95% certified efficiency on NBS Atmospheric Air Dust Stain Rating.



M-S-A® Air-O-Kay* PreFilter

Impingement type panel prefilter which can be used oiled or dry to remove lint and other large airborne particles from the atmosphere. 60-70% certified efficiency on NBS Stain Rating.

Write for illustrated technical bulletins on M-S-A Space Filters related to your particular system problem. Ask an MSA Representative for system recommendations.

Other Fluid Purification Equipment includes catalytic filters for jet aircraft cabin air; air separation plants; inert gas generators; space capsules; bomb shelters; air line filters; jet fuel and hydraulic fluid purification.

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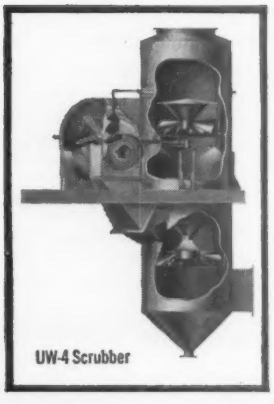

UW-4 Scrubber

There's an old song that goes something like this: "It Ain't What You Do; It's The Way That You Do It." This holds true for wet dust collection and one of the most effective ways of doing it is dynamically with a Ducon UW-4 Scrubber.

The centrifugal forces and water action inside this scrubber, combining with the unique and effective dynamic action of the high velocity fan in the second stage of operation, literally swirl, swat and scrub all the dust particles from the gas stream.

The UW-4 Scrubber is a most effective unit for separation of extremely fine dusts and abrasive materials and is ideally suited for heavy dust loads and high temperature applications.

Send for Bulletin 7460.

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EDITORIAL:

Controlled Atmospheres . . . Modern Key To Profits!

THE DUST motes you've seen dancing in a ray of sunshine in a quiet room can lose your company a year's profit . . . even lose your country a war!

The military specifications for assembly of ultra-precise guided missile components, micro-miniaturized electronic telemetering equipment and for containment of radioactive dust, call for super-clean atmospheres, unknown a decade ago.

Today, super-clean areas, sometimes called "White Rooms" or "Gray Rooms" and varying in size from one room to an entire plant, are paying dividends to manufacturers smart enough to employ air engineers who know how to apply these controlled atmosphere techniques.

AIR ENGINEERING has presented articles and technical data on these super-clean controlled air areas, and will continue to do so in the future. The air engineer in industry who recognizes the benefits of super-clean air and who knows how to apply these benefits to help his company or his clients make their products faster, better, at lower cost, is the man who will reap the greatest personal rewards.

Most obvious of the growing needs for controlled atmospheres, of course, is in the area of the inertial guidance systems and other equipment that goes into missiles.

Growth of the missile business, as Fortune Magazine pointed out in its June, 1960, issue (p. 134) will benefit "the companies that are expert in the chemistry of high energy fuels; in the technology of metals and plastics . . . in the techniques of miniaturizing computers and radio transmitters that can be trusted to aim a hundred-ton projectile within a mile of the desired target or relay a signal 50-million miles from the vicinity of Mars; and in all the other scientific disciplines as well that have made possible the vault into space."

All of these technologies will require super-clean, controlled atmospheres of one kind or another.

What about the rest of us, in less glamorous industries? Alert air engineers have in recent years applied super-clean air techniques in a score of ways. For instance, a large automobile producer had for several years been using super-clean areas for the assembly of military components. When automatic transmissions came along, with their low tolerance bearing surfaces, that dust mote dancing in a ray

(Please turn to following page)

Editorial (Cont.)

Controlled Atmospheres . . . Modern Key To Profits!

(Continued from preceding page)

of sunshine suddenly turned into a golf ball that fouled up the works. The result . . . this auto producer's automatic transmission assembly is now done in super-clean conditions, under controlled atmospheres of temperature and humidity.

When optical comparators of today can check tolerances as low as one-millionth of an inch, that tiny dust mote is indeed a golf ball by comparison with today's tolerances for many a consumer goods product.

We know of a manufacturer of baby foods who developed a new infant diet product having exacting standards of purity, which had to be blended while under refrigeration. It was found that airborne bacteria made its way, along with dancing dust motes, into this product as it was packaged. This bacteria caused spoilage and greatly reduced shelf life of the product in stores. After the packaging operation was moved to a super-clean area, in which particles as small as .03 microns were filtered out by super-interception filters, no further trouble was experienced.

Or, take the case of the cottage cheese industry. At first glance super-clean rooms bear little relationship to cottage cheese. However, this industry had long been plagued with a bacteriophage which attacked the culture germs which make cottage cheese taste and look so good. The result . . . cottage cheese that either looked okay and tasted horrible, or looked horrible and tasted okay. Then some smart air engineer figured out a way to use war-born super-clean atmosphere techniques to filter out the bacteriophage and the age-old trouble was ended forever.

There's research going on right now in the farm industry using super-clean controlled air techniques to improve quality of livestock and reduce the price of your morning bacon. Livestock experts are experimenting with a new method of wholesale Caesarean delivery of baby hogs, notoriously prone to drafts and bugs, in super-clean controlled air atmospheres.

Pharmaceutical manufacturers are continuously fighting product contamination, from airborne chemicals, germs and dust; as are producers of photographic products.

Is there an application of super-clean controlled atmospheres in *your* plant or in the plant of your client, that can save money? Look for areas where products are super-machined, are small, precise, affected by dust, heat, high or low humidity, mold, mildew, rust, bacteria or radioactivity.

Clean air and accompanying control of temperature and humidity can be the key to profits for *your* firm or client. ▲▲

Eugene A. Sloane

Editor

Meetings, Courses, Expositions

Gordon Research Conference on Toxicology and Safety Evaluations, *Kimball Union Academy, Meriden, N. H., Aug. 15-19.*

Special summer program on Noise Reduction, *Massachusetts Institute of Technology, Aug. 22-Sept. 2.*

Western Electronic Show and convention, *Memorial Sports Arena, Los Angeles, Aug. 23-26.*

Production Engineering Show, *Navy Pier, Chicago, Sept. 6-16.*

American Chemical Society fall meeting, *New York City, Sept. 11-16.*

East Central Section, Air Pollution Control Association, *Sheraton-Cadillac Hotel, Detroit, Sept. 22-23.*

Instrument Society of America 15th annual meeting, *New York Coliseum, New York City, Sept. 26-30.*

American Gas Association, 42nd Annual Convention, *Convention Hall, Atlantic City, N. J., Oct. 9-12.*

National Metal Exposition, *Philadelphia Trade and Convention Center, Philadelphia, Oct. 17-21.*

Industrial Hygiene Foundation of America, Inc. 25th annual meeting, *Mellon Institute, Pittsburgh, Oct. 26-27.*

Institute of Boiler and Radiator Manufacturers semi-annual meeting, *Seaview Country Club, Absecon, N. J., Week of Oct. 31.*

National Hotel Exposition, *New York Coliseum, New York City, Nov. 7-11.*

Building Research Institute Fall Conference, *Shoreham hotel, Washington, D. C., Nov. 15-17.*

Air-Conditioning and Refrigeration Institute annual meeting, *Hollywood Beach hotel, Hollywood Beach, Fla., Nov. 18-22.*

Refrigeration and Air Conditioning Contractors Association convention, *Fontainebleau hotel, Miami Beach, Fla., Nov. 20-23.*

24th National Exposition of Power & Mechanical Engineering, *New York Coliseum, New York City, Nov. 28-Dec. 2.*

First Industrial Building Exposition & Congress, *Coliseum, New York City, Dec. 12-15.*

Industrial Heating Equipment Association, Inc. meeting, *Dearborn Inn, Dearborn, Mich., Jan. 23-24, 1961.*

American Society of Heating, Refrigerating, and Air-Conditioning Engineers semi-annual meeting and exposition, *International Amphitheatre, Chicago, Feb. 13-16, 1961.*

National Association of Corrosion Engineers annual conference and corrosion show, *Statler hotel, Buffalo, N. Y., March 13-17, 1961.*

American Chemical Society national spring meeting, *St. Louis, March 21-30, 1961.*

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Demo Party Platform Against Air Pollution

About half-way through his reading of the Democratic Party Plank during the recent L.A. Convention, Chester Bowles read a statement about a need for nation-wide control of air pollution. Robert Barksy, Los Angeles District Air Pollution Control public information officer, had prior to the convention, forecast little smog over the Sports Arena "due to micrometeorological conditions, such as a local accumulation of hot air."

Cooling Towers Spring Leaks Because Of Air Pollution

The air conditioning cooling towers in the McGraw Hill Building, N.Y.C., picked up so much sulphur contamination from the air, according to Water Service Laboratories, Inc., that leaks developed in tower piping after 18-months operation.

Air Pollution In The News

August issue of Consumer Reports devotes eight pages to air pollution. CU made a survey of the Upper Ohio River Valley, concluded that in steel cities like Weirton and Wheeling, W. Va., and Steubinville, Ohio, air is "shockingly dirty," and that steel mills know how to stop polluting the air, but won't unless city fathers make them.

In the Current Medical Digest, in an editorial on air pollution, Robert B. Martin, M.D. states that "With air pollution and cigarette smoking both possible causes of cancer, the public is understandably confused. Whether to stop smoking or stop breathing leaves little alternative."

Air Conditioning Aids Child Behavior Studies

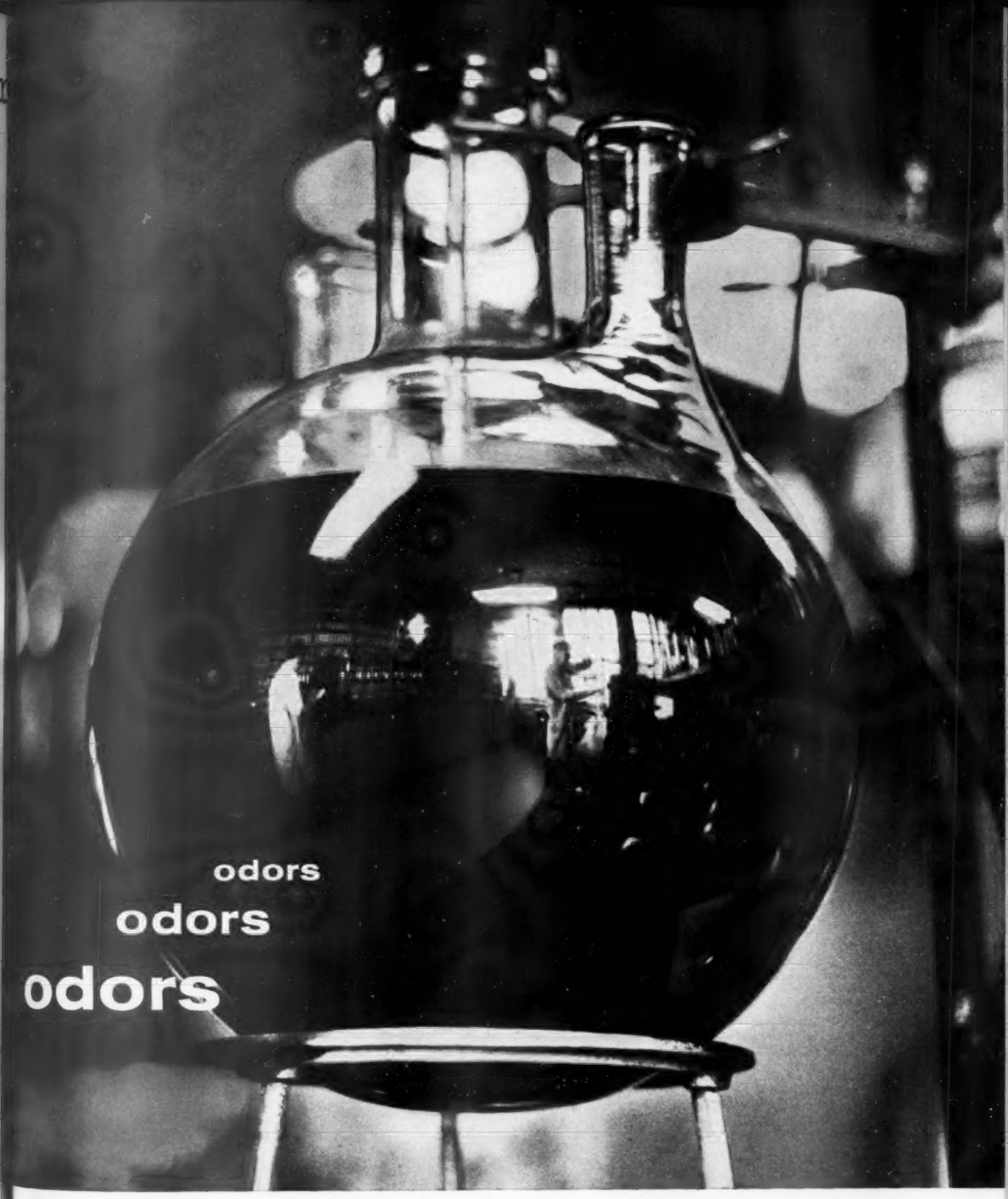
A controlled atmosphere in the new $1-million dollar Program Building at Merrill-Palmer Institute, Detroit, will eliminate one of the variables in child behavior studies, according to David J. Williams, development director of the Institute. "No longer will we have to allow for changing attitudes and moods caused by the weather," he said. School building was designed by O'Dell, Hewlett and Luckenback Associates, architects-engineers. Cooling system will use Carrier absorption unit.

Gas Heat Costs Less In 'Functionally' Identical School, Study Says

A comparative study of two "functionally identical" schools in Angola, N. Y., by the University of Buffalo, shows that heating cost for the gas-fired school was less than half that of the electrically heated school, and that initial installation costs for the gas heat system were $6500 less than the electrical system. Further data is on file at American Gas Association, 420 Lexington Ave., N.Y.C.

Animals Get Better Cooling Than Humans In New Laboratory

Animals used for pharmacologic and toxicologic research at Baxter Laboratories, Inc., new Morton Grove, Ill., lab building will live in a uniform atmosphere far better than that provided for guests at the most exclusive hotel. Controlled atmospheres for animals help eliminate variables such as temperature, humidity and other externally received stimuli. System is designed to hold 75F, ± 1F, 50 percent RH, ± 2-3 percent, and draft-free air distribution at 15 changes per hour.



control of odors...

is an everyday pursuit at the Airkem laboratory. Research teams explore the practical chemistry of counteracting industrial malodors. Methods developed by chemists, applied by engineers help create a healthier, odor-free environment at many plants.

Airkem research employs pilot plant studies to simulate field conditions. Result: new techniques for operating plants as acceptable neighbors in almost any community. Perhaps this research can help you . . . it has helped government and industry around the world. Write for a detailed bulletin on odors, their technology and control, and for the address of the local Airkem Specialist serving your community—there are 190 offices here and abroad. Airkem, Inc., Industrial Division, Dept. AE-860, 241 E. 44th St., N. Y. 17, N. Y.

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FOR A HEALTHIER ENVIRONMENT THROUGH MODERN CHEMISTRY

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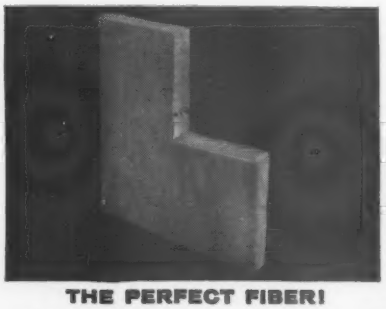
THE STARTLING FACTS ON THE

New ULOK BRAND Cube

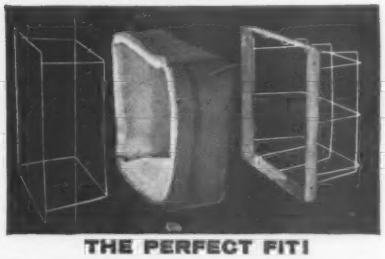


THE PERFECT FIBER!

UNION CARBIDE research has produced the truly ideal filter medium in DYNEL modacrylic fiber—a strong, high capacity fiber with an irregular, highly arresting cross section.

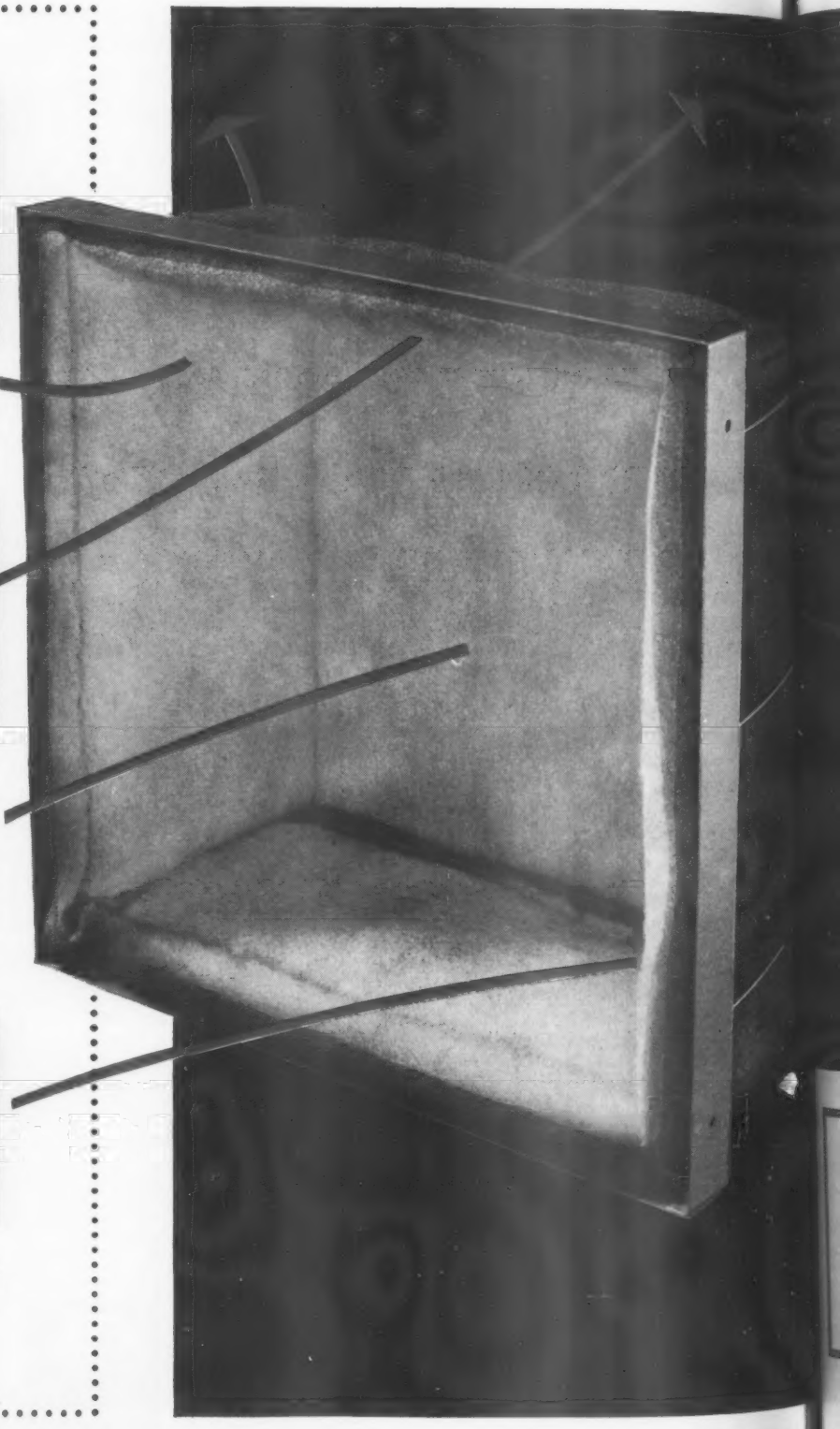
THE PERFECT FORM!

Basic component is a low density, three-dimensional batt, sewed into cube shape. Rust-proof retainer frame is inserted in batt, then batt is inserted in wire retaining basket. Final three-piece assembly is supported by holding frame within unit, is easy to handle—no sharp edges or "splinters". Easy to dispose of when full—simply collapse and discard . . . the dust is in the bag!



THE PERFECT FIT!

Shape of retainer frame inside batt permits filter to seal itself in holding frame. Final filter assembly is a tight, leak-proof, press fit.



eType Air Filter:

New Filter Medium!

DYNEL filter medium stops and holds unusually large quantities of dirt. Self-sealing, leak-proof assembly completely eliminates problem of filter bypass . . . provides maximum economy at highly acceptable filtration levels.

Saves Change-Over Dollars!

ULOK Cube Filter lasts 6 times longer. Dirt is first trapped on inside face of filter. As dirt builds up, air flow is shunted to large filtering area of four sides. Thus, even after several *pounds* of dirt have been collected, high filtering efficiency and low pressure drop is maintained. This "reverse loading" process increases service life *6 times* over that of conventional filters. Think of the savings in maintenance!

Uses Half The Space!

Medium-size ULOK Cube Filter has a filtering surface of 1040 sq. in.—140 more than a conventional 30″ x 30″ flat filter—yet it presents a frontal area of only 20″ x 20″. Filter bank area can thus be reduced by *half* with medium-depth filter, *even more* with deeper models.

At All Velocities!

ULOK Cube Type Air Filters afford the high filtering efficiency characteristic of low velocity units even in units employing air volumes as high as 1970 cfm!

Proved In Operation!

ULOK Cube Type Air Filters have been soundly proved in numerous installations. Reflecting a complete range of the filtering problems presented under varying operating conditions, these field trials were complemented by extensive and extremely severe laboratory tests.

Ideal for all commercial and industrial air conditioning, heating, and ventilating systems, ULOK Cube Type Air Filters are available in 12 sizes to meet any requirement.

WRITE TODAY FOR FURTHER INFORMATION AND PRICES.

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NEWS of the Industry

Develop Instrumental Technique for Automatic Particle Size Analysis

A new instrumental technique for automatic particle size analysis—a nuclear achievement of primary importance for industries which have sought a precise, rapid, and economical method to measure particle size and distribution—was reported before the annual meeting of the American Nuclear Society by Dr. Jane Connor of Evans Research and Development Corp.

Intended for general use, both in industry and in the laboratory, this particle analyzer is said to be safe, non-destructive, and adaptable for continuous on-stream sampling, in dry or liquid state, without interfering or affecting the flow of production. Theory of the Evans analyzer is based on a beta-ray, back scattering technique which measures the magnitude of fluctuations or the "spread" in a random sampling operation under specific geometrical conditions. Its source of radiation is Carbon 14.

Detroit Air Pollution Bureau Assigns Man as Noise Control Consultant

"Noise and vibration control activities" grew to the point where they represented 12% of all the complaints registered to the Detroit Bureau of Air Pollution Control, reports Morton Sterling, Bureau chief.

This increased activity has necessitated the assignments of one air pollution inspector to serve as the Bureau's noise control consultant.

Air Conditioning To Save School Board $3,000 This Year

An investment in air conditioning will save the Alton, Ill. Board of Education nearly $3,000 in operating costs this year, says Dr. J. B. Johnson, superintendent of schools.

Dr. Johnson said the air conditioning system installed in the board's headquarters three years ago already has paid for itself and this summer will produce dividends in the form of savings on salary expenses. Before the building was air conditioned, the board had to hire four extra employes during the summer to help the regular staff complete its work.

This Fall, Alton will have two air conditioned elementary schools. A complete cooling system has been installed in the 11-room Eunice Smith school which was built in 1958.

"We plan to air condition all our new buildings," Dr. Johnson said. "We are also considering equipping those constructed during the last decade. We have factual evidence that shows students and teachers work better in a controlled atmosphere."

Move To Set Up Precipitator Standards

A step toward establishment of standards relating to electrical precipitators—which will lead to better control of industrial air pollution—was taken recently by a group of management engineers meeting at Ponte Vedra, Fla. The group comprises the Electrical Precipitator Division of the Industrial Gas Cleaning Institute formed last year to advance techniques in the manufacture and operation of air pollution control equipment.

The Institute is composed of four divisions representing the principal dust and fume collection equipment lines: electrical precipitators, mechanical collectors, fabric filters and wet scrubbers. At their first annual meeting, members of the Electrical Precipitator Division launched their program by discussing such topics as industry standards and research efforts, among others. Foremost among the problems to be solved by the group's engineering committees are those dealing with equipment ratings, industry terminology, test methods, standards of performance, and equipment usage.

Representatives of Aerotec Industries, Buell Engineering Co., Research-Cottrell, Western Precipitator Division of Joy Mfg. Co., and Koppers Co., Inc., attended the electrical precipitator meeting.

Caution Consumers About Electronic Air Purifiers

In sounding a word of caution to consumers about the use of electronic air purifiers in their homes, the Baltimore Safety Council said ozone generated by the devices "is a highly poisonous gas." Earl W. Smith, managing director, stressed that he was not talking about air conditioning units, but about "air cleansing devices, sometimes called ozonators."

"There is a controversy centering around whether the amount of ozone produced is sufficient to poison humans. Manufacturers say it isn't; some others disagree."

Another warning on ozone has been sounded in the "Occupational Health Bulletin" published by the Occupational Health Division, Department of National Health and Welfare of Canada, which says of advertising that claims ozone removes odors:

"While it is true that ozone in sufficient concentrations can chemically destroy odors, concentrations which have this effect are known to be damaging to health. Indeed, ozone is rated as one of the most toxic substances known; one thousand times as toxic as carbon monoxide, for example. The very low level at which ozone produces its maleffects is evident from the threshold limit of 0.1 ppm by volume or 0.2 mg per cubic meter in air, adopted by the American Conference of Governmental Industrial Hygienists."

Welfare Secretary Proposes Bureau of Environmental Health

A new bureau of environmental health would be established in the proposed reorganization of the U.S. Public Health Service requested by Secretary of Welfare Arthur S. Flemming.

Regarded as likely to be shifted from the Bureau of State Services to the proposed new Bureau of Environmental Health are such activities as water pollution control, air pollution control, and radiological health.

Astronaut Tracking Stations Require Air Conditioning

Twelve of the tracking stations that will monitor the course of the first U.S. astronaut in space are being equipped with air conditioning systems produced by Westinghouse Electric Corp. The installations, strung out in a pattern that encircles the globe, are being built for the National Aeronautics and Space Administration "Project Mercury."

The stations will have complex ground electronic apparatus requiring precise environmental and atmospheric control. Because the ambient varies widely in the locations which range from tropic to temperate, equipment cooling requirements differ from station to station. Central air conditioning systems, with separate water chiller and air-handling components, will serve the large buildings housing the manned tracking and transmission apparatus. The systems will range from 20 to 40 tons' cooling capacity.

Self-contained "Unitaire" conditioners will serve auxiliary buildings. Air conditioning equipment has already been shipped for five of the installations being constructed by Burns & Roe, Inc., New York engineering and consulting firm, for Western Electric, the prime contractor.

Study Possible Link Between Lead In Air, Multiple Sclerosis

A possible connection between the crippling disease multiple sclerosis, and lead in air, food, and drink, is called a distinct possibility by Dr. Harry V. Warren, University of British Columbia geologist, who says he has found indications of the relationship and plans further investigation.

Dr. Warren began to suspect a relationship of the disease and lead when he noted a striking resemblance between maps showing incidence of the disease and geological maps showing mineralization high in lead. The object will be to determine areas of high lead content, either from underground mineralization, industrial fumes, or car exhausts, and relate the findings to the frequency of sclerosis in the sampled area.

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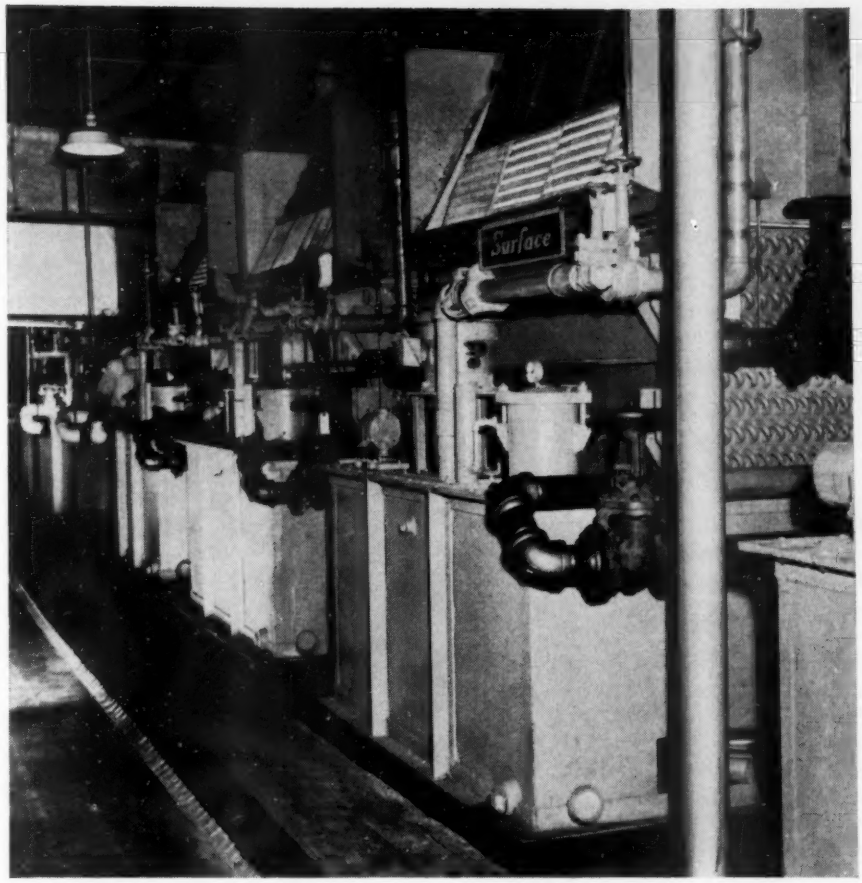

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NEWS of the Industry . . .

(Continued from preceding page)

East Central APCA Meeting To Be In Detroit Sept. 22 to 23

Viewpoints representative of the many different factors in government and industry concerned with air pollution control will be presented in the program of the 1960 East Central Section APCA meeting to be held Sept. 22-23 at the Sheraton Cadillac hotel, Detroit. Between the technical sessions at the two-day meeting there will be an equipment manufacturers clinic for the delegates to visit.

Thursday

Following the welcoming address on Thursday morning, Sept. 22, by Morton Sterling, chief, Bureau of Air Pollution Control, Detroit, the keynote address "General Appraisal of Air Pollution Problem" will be given by Dr. Louis C. McCabe, president, Resources Research, Inc. Following this will be a talk on "Trends in Air Pollution Legislation" by Paul Giever, resident lecturer, School of Public Health, University of Michigan.

Balance of the first morning's session will be taken up with a panel discussion on "The Air Pollution Control Team" with "role" of each team member being discussed as follows: "Researcher"—Andrew H. Rose, Jr., Department of Health, Education & Welfare, Cincinnati; "Equipment Manufacturer"—Ellis Smauder, president, American Incinerator Corp.; "Industrial"—Jack C. Radcliffe, supervisor, Industrial Safety Section, Ford Motor Co.; "Consulting Engineer" — Peter Janus, chief draftsman, mechanical department, Giffels & Rossetti, Detroit; "Air Pollution Control Official"—Ross V. Doughty, Department of Service and Buildings, Dayton. Moderator for this session will be Bernard Bloomfield, Michigan Department of Health.

Luncheon speaker on Thursday will be Dr. A. A. Canfield, director of Scientific & University Relations, The Bendix Corp., who will speak on "Psychology of an Enforcement Program." Thursday afternoon session will cover "New Techniques for Solving Some Unique Air Pollution Problems" with Lazier Stevens, chief of air pollution control, Wayne County (Detroit) Department of Health, serving as moderator. The three-part discussion will include: "Bag Houses on High Humidity Fume Problems" by Robert Wright, Dust Control Division, American Air Filter Co.; "Tepee Incinerator for Scrap Wire Reclamation and Its Possible Adaptation for House Wrecking Wastes," Albert W. Spitz, Trio Process Corp.; "Catalytic Combustion of Fumes from Food Processing Industry," Richard Ruff, president, Catalytic Combustion Corp.

Two papers will conclude the Thursday afternoon session: "The Present Status of Research on Air Pollution Health Relationships," by Dr. Ralph Smith, associate professor, Department of Industrial Medicine and Hygiene, Wayne State university; and "Control of Radioactive Wastes at Enrico Fermi" by J. G. Feldes, Power Reactor Development Corp.

Friday

Friday morning (Sept. 23) session will open with a paper "Current Status & Future Work on Vehicle Emission Control Devices" (author not yet selected) to be followed with a paper "Carbon Monoxide As an Air Pollutant—A Factor in Traffic Accident Causation?" by Prof. Warren A. Cook, School of Public Health and Research Association, University of Michigan.

Fredrick To Talk

Concluding the session will be a panel discussion "Air Pollution Control—A Basic Element in a Company Expansion or Relocating Program" with Dr. W. G. Fredrick, director, Bureau of Industrial Hygiene, Detroit Board of Health, serving as moderator, with the following participants: "Big Business Official" (not yet named); "Small Business Official"—Sheldon Hayes, president, Cadillac Asphalt Co., Detroit; "Legal Representative"—Dr. Melvin Nord, Coleman, Nord & Krass, Southfield, Mich.; "Technical Advisor"—George Clayton, president, George D. Clayton & Associates, Detroit; "Air Pollution Control Officer"—Louis E. Bunts, Department of Air Pollution Control, Akron.

Arnold Arch, APCA executive secretary, will speak at the closing luncheon, following which there will be a tour of the Enrico Fermi atomic power plant near Monroe, Mich.

Louisville Adopts Recommendation Of Local Study

Louisville's city-county Air Pollution Control Board has adopted a recommendation made in a special study of local, state, and federal authorities, that would require plants emitting odorous chemical emissions be required to decrease them by 90 percent.

Ralph Bourne, chief engineer for the board, said he will obtain copies of the full technical report for study by the various plants tested. He will then confer with the plants to pinpoint sources of trouble and will try to work out solutions.

This marks the fourth recommendation of the survey to be adopted. The board previously had moved to reduce emission of solid particles produced by the burning of fuel, reduce emission of particles produced by industrial operations, and reduce emission of hydrocarbon vapors from the evaporation of fuels.

North Carolina Health Board Scores Pollution

Blaming polluted air for damage to health, property, or animal life in almost one-third of North Carolina's 100 counties, the State Board of Health said conditions were sufficient to cause nuisance or inconvenience in 72 counties, with damage reported in 30 counties.

"Air pollution" said the board in reporting on its study, "is a matter of increasing concern in North Carolina. Problems result from smoke from industries, dust and fumes, especially in areas with prolonged periods of atmospheric stagnation." The board said North Carolina is located in an area where prolonged periods of atmospheric stagnation occur more frequently than in most other parts of the nation.

Detroit River Case In Top U. S. Court

The "test case" case challenging the constitutionality of the application of the Detroit Air Pollution Control ordinance against ships navigating the Detroit River that violate provisions of the ordinance, has moved closer to resolution. After the Michigan Supreme Court upheld the application of the ordinance, the case was appealed to the U.S. Supreme Court where briefs have been submitted and oral arguments are scheduled to be heard this year. It is believed that the Supreme Court decision will set a precedent in the field.

In the meantime, efforts continue to find a voluntary solution to the problem. A special smoke abatement committee of the Great Lakes Air Pollution Abatement Program organization has been formed to discuss possible steps the American Great Lakes shipping industry could undertake to abate the problem.

Atmospheric Study Center Set Up with $500,000 Grant

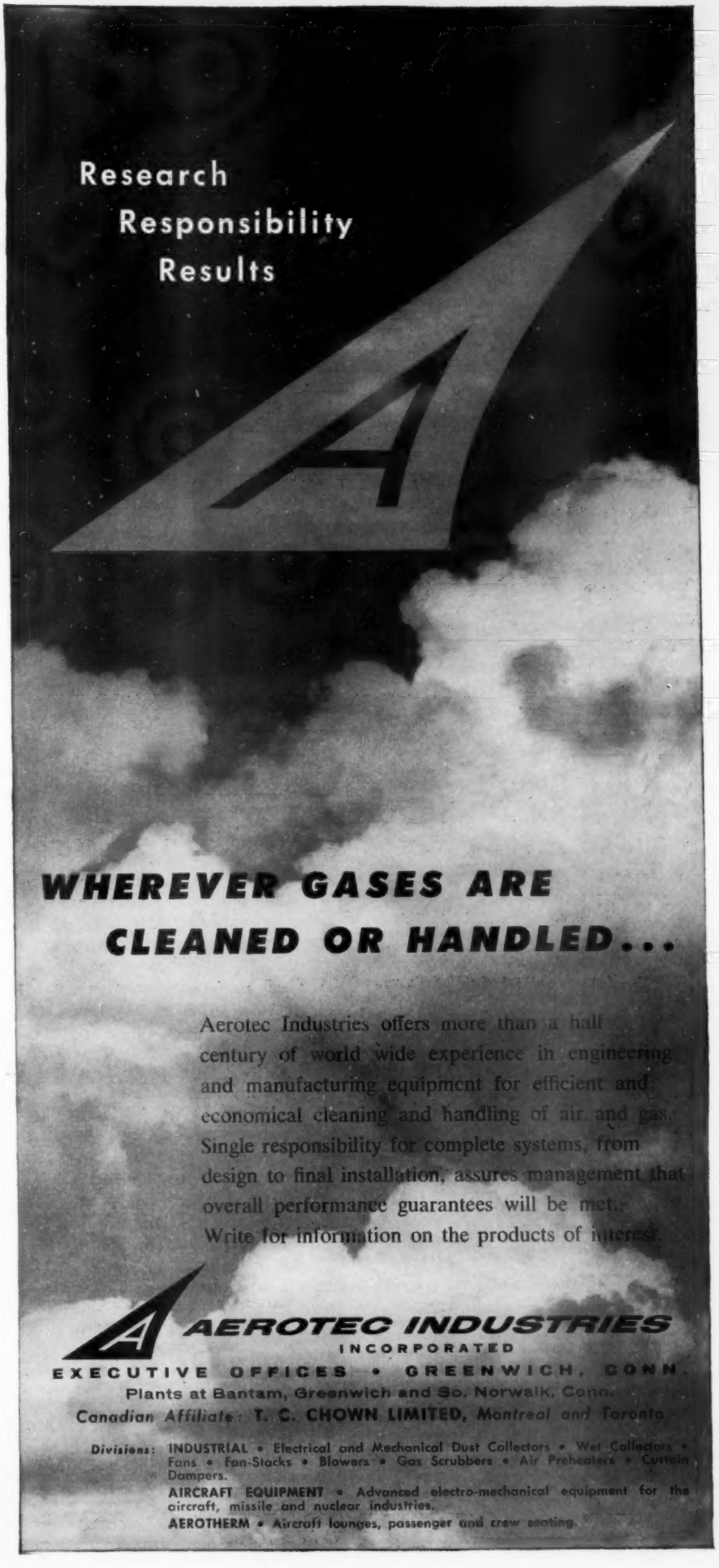
A $500,000 grant to establish a national center for atmospheric research has been made by National Science Foundation to the 14-member University Corporation Atmospheric Research.

The national center, to be located at Boulder, Colo., will consist of a central scientific group to stimulate and supplement university research. Research will probably fall into four categories—atmospheric motions; energy exchanges in the atmosphere; the chemistry of the atmosphere; and physical phenomena.

(Please turn to following page)

Use Communications Center, page 37, for requesting more information about articles, advertised products, literature, and for comments about any of the editorial material in this issue of AIR ENGINEERING.

If you wish to contact manufacturers directly, street addresses are given. But please mention you saw it in AIR ENGINEERING.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Pollution Complaint$

Buffalo, N. Y.—In the wake of recurring complaints from South Buffalo residents about smoke and soot from the Lackawanna Plant of Bethlehem Steel Co., a county wide air pollution control unit has been set up.

• • •

Allentown, Pa.—Lehigh Valley Air Pollution Control Board has asked eleven cement plants within its jurisdiction to hire outside engineering firms to check stack emissions for ordinance compliance. Specifically in question are the Nazareth Cement Co., Penn-Dixie No. 4 and Giant plant.

• • •

Toledo, Ohio — City inspection division is moving toward a forced shutdown of coal pulverizing equipment at Maumee Malleable Castings Co., because dust from the pulverizing operation is allegedly in violation of local air pollution ordinances.

• • •

Saddle Brook, N. J.—Complaint against Sommers Rendering Plant charging firm permits escape of noxious odors into outside air has been signed by local sanitary inspector. Superior Court Judge J. J. Grimshaw, Jr., has ruled that odors must stop immediately or plant will be closed.

• • •

Pocatello, Idaho — The Idaho Supreme Court recently told Fifth District Court to accept evidence intended to show the effect of the Simplot plant on the economy of Southeastern Idaho. Plant is under local fire from owner of night club across from the plant, who alleges that Simplot plant emits smoke, dust and fumes. Plant employs about 1000 persons, makes fertilizer, has spent over $223,000 for fume and dust control to date.

• • •

Maspeth, L.I., N.Y. — Residents of Greenpoint - Maspeth, Long Island area have kicked off action by New York's Department of Air Pollution Control against local industries. Plants cited include a plastics plant, a pickle factory, a glue plant, a laundry and a smoked-meat processor, among others. Odor problem in the area is said to be so complex that an inspector "often has trouble sniffing out a single offender in the noxious combination of smells."

• • •

Pocatello, Idaho—Central Farmers Fertilizer Co., near Georgetown, was named by area residents as a source of noxious smoke and odors at a meeting of the Idaho Air Pollution and Control Commission. However, company officials stated that control equipment at the plant was at least 90 percent effective in removing noxious materials in the smoke.

• • •

Cleveland, Ohio — Suit to halt construction of a private incinerator in Hambden Township, Geauga County, by Geauga Disposal Co., has been filed by residents of Hambden Township.

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NEWS

(Continued from preceding page)

N. Y.-New Jersey Group Agrees On Procedures

The New York-New Jersey Cooperative Committee on Interstate Air Pollution has agreed upon certain procedures to carry out objectives of the groups.

Air pollution problems are classified into four categories: those stemming from industrial accidents or breakdowns of normal operating procedures; incidents in which the source is believed to be outside an agency's jurisdiction and the source and cause are unknown; routine pollution which becomes of interstate concern because of wind and weather conditions; and atmospheric stagnation, a general build up of air contaminants over a wide area because of prolonged temperature inversions and low wind speeds.

Uniform maps and prompt communication will be used to determine the location of air pollution incidents, those situations in which the area of complaint is in a jurisdiction different from the area of origin. The information exchanged will include an opinion on the public health significance of the problem. The New York City Department of Air Pollution Control, with its meteorological facilities, will serve as a coordinating point for weather information. In problems involving air stagnation, each agency will attempt to obtain levels of air contaminants. If it appears that the levels constitute a situation hazardous or potentially hazardous to the public, an emergency meeting of agency representatives can be called to expedite a uniform plan of action.

Automatic Kiln Doors Abate Air Pollution

Two new gas-fired limestone kilns for producing burned lime and improving the quality of the lime, being put into operation at The Blair Limestone Div., Jones & Laughlin Steel Corp. in Martinsburg, W. Va., will have automatic door controls for the kilns, as a step towards air pollution abatement.

Questions And Answers . . . .

You are cordially invited to send your technical questions on any phase of air engineering to the Question and Answer Department. Questions will be welcomed on industrial ventilation, hood design, air conditioning, air pollution control, dust collection and allied subjects.

Dust Monitor For White Rooms

Question:

Is there a dust monitor available for use in ultra-clean rooms that could monitor and record on a practical basis, hourly readings? Range approximately 0.4 to microns.

I.M.K.
Albuquerque, N. M.

Answer:

There are a number of dust determining instruments available commercially for monitoring room air. These instruments require manual counting or evaluation. These instruments include:

(A) *Spot checking instruments*[1][2] which deposit the sample on a glass plate with space for a number of samples. These instruments sample with a hand pump and include a built-in microscope for counting samples on the spot. One instrument utilizes the Darkfield counting technique, which is useful in evaluating extremely fine dust in relatively clean air.

(B) *Automatic paper tape sampling equipment*[3] is available with a time clock mechanism for sampling at a number of intervals during a 24-hour period. Air is metered through a paper tape, depositing a spot of dust. The darkening from the dust can be evaluated photoelectrically and compared with known standards. Automatic impinger sampling equipment is also available; however, the samples are generally evaluated by tedious counting techniques.

Automatic sampling and recording equipment has been described in literature[4][5]; it is doubtful if this type of equipment is readily available, commercially. One device[4] described, photoelectrically counts the dust particles. The principle is as follows: Air passes through an inspection zone of known dimensions sufficiently small so that most of the time there is not a single dust particle in the inspection zone. Occasionally a dust particle will pass through; the instrument determines the fraction of time that such particles are present. The dust concentration in particles per a cubic foot is directly proportional to this fraction of time. Lower limit is 0.2 microns.

Another continuous dust recorder[5] described samples the dust by high velocity impingement in the form of a continuous ribbon upon a moving strip of adhesive coated celluloid film. Sampling rate and film speed are constant, the density of dust deposit varies with concentration. The density is measured photo-electrically.

BIBLIOGRAPH AND INSTRUMENTS

(1) *Dust Counter.* Bausch and Lomb Optical Co., Rochester 2, N. Y.

(2) *Conimeter.* C. A. Brinkman and Co., Great Neck, Long Island, N. Y.

(3) *Aesco Automatic Filter Paper Sampler.* Air Sampling Equipment, Cleveland, Ohio.

(4) Joseph C. Fromer *(Patented Counter),* 1525 Teakwood Ave., Cincinnati 24, Ohio.

(5) Drinker, P. and Hatch, T., *Industrial Dust,* 1st. Edition P. 107, McGraw-Hill.

●

Fume Short-Circuiting

Question:

We have a problem in connection with a multiple low pressure boiler installation burning CSG No. 6 fuel oil where, for aesthetic reasons, the stack does not have a sufficient height to disperse the products of combustion at a suitable distance from the fresh air intakes.

When the wind is from one particular direction the leeward wall of the building causes products of combustion to eddy and fall into fresh air intakes.

The fumes are thus circulated in the building with obvious results. Of course there is also the problem of soot.

H.L.A., Virginia

Answer:

Without the benefit of architectural drawings and equipment details, a specific recommendation on the solution to this problem is inadvisable. The overall problem can be divided into two basic problems:

1. dissipation or collection of soot.
2. dissipation or collection of odors.

If the stack cannot be raised to increase the distance from the "gas" discharge point to the fresh air intake openings, then perhaps the fresh air intake openings could be moved with respect to the present stack outlet.

This can be accomplished by installation of a horizontal "entrance" duct on the fresh air intake

(Please turn to page 53)

Fig. 1: *Humidity-conditioned air is delivered from humidity control unit through grilles spaced along sides of a straight duct, down the center of a large drafting room at Caterpillar Tractor Co., Peoria, Ill. Photo courtesy Surface Combustion Div., Midland-Ross Corp.*

Air engineers at Caterpillar select . . .

Humidity Conditioners . . . Save 100 Tons of Cooling

How LCL units save 100 tons of refrigeration capacity and maintain design conditions of 82F d.b. and 30% r.h. is told in this article.

By 1953, a dwindling supply of well water had undermined the once-adequate evaporative-type air conditioning system that for over 25 years had served Building TT at the Peoria tractor plant of the Caterpillar Tractor Company. A severe drop in the water table in the Peoria area the previous summer had required recirculation of the 62F well water to the extent that cooling was actually provided on less than 15 days during the summer and room humidity rose as high as 70 percent. The plant engineering group in Peoria had by that time completed a thorough study of available types of air conditioning systems with respect to relative performance, cost, and structural requirements.

A combination cooling-dehumidifying conditioning system with a much increased air-handling capacity was installed in early 1954 and in the years since has maintained consistently comfortable temperature and humidity conditions in the 776,000 cu. ft. of space in Building TT. By including humidity conditioning units in the system, it was possible to reduce the capacity of the cooling equipment by approximately 100 tons of refrigeration.

Purposes of Conditioning System

The primary purpose of the new conditioning system, of course, was to provide greater personal comfort for the more than 900 people in the Engineering, Tool Design, Purchasing, Business Machines, and Inventory Control Departments located in building TT. Secondly, the plant engineers wanted to eliminate intermittent – and often very irritating – difficulty with curling and sticking of paper, engineering drawings, and business-machine cards in periods of high room humidity.

A design goal was established to maintain 82F dry bulb temperature and 40 percent RH in all areas with maximum outside air temperatures of 95F dry bulb and 78F wet bulb. In order to insure these conditions throughout the two-story building, the total air handling capacity of the new conditioning system was set at 80,000 cfm in comparison to an inadequate 30,000 cfm in the original system. Not surprisingly, it was necessary to achieve this system performance while keeping the initial capital investment as low as possible and minimizing the structural changes in the existing building.

Combined Cooling-Dehumidification System

The two air distribution systems handle a total of 80,000 cfm, of which 50,000 cfm is recirculated air at about 82F dry-bulb and 30,000 cfm is outside air dehumidified to 30 percent RH. The total air volume is then passed through chilled water coils, where primarily sensible cooling is accomplished, and the conditioned air is distributed to the various areas of the building. The cooling tower is supplied with chemically treated and filtered water from the nearby Illinois River, conserving well water for drinking and use in the cafeterias.

The moisture content of the room air at the specified conditions of 82F dry-bulb and 40 percent RH is 66 grains per lb. of dry air. Since the latent heat load involved in maintaining this level of specific humidity is absorbed by the dehumidified outside air, the chilled-water system need only take care of the sensible heat load and a capacity of 250 tons is adequate. Without dehumidification, it would have been necessary to install another 100 tons of refrigeration to maintain the required moisture level.

Two Conditioning Zones

The air conditioning units and distribution systems are divided into two zones, East and West – including mostly the first and second floors, respectively. Dehumidification is provided in each zone by a chemical humidity conditioning unit. The larger 17,500 cfm unit receives outside air during the summer at any temperature and humidity, automatically reduces its relative humidity to 30 percent at 95F and feeds it into the intake system for the first floor. The other humidity conditioning unit (12,500 cfm) handles the smaller conditioned-air needs of the second floor.

While the fans in the distribution network circulate the air all year-round, the humidity conditioning units are shut off during winter months. During cold weather, outside air is introduced into the distribution ducts and is warmed by reheat coils at appropriate points in branches of the system.

The large drafting room in Fig. 1 and the private offices in Fig. 2 represent different types of spaces served by the conditioning system. In Fig. 1, grilles spaced along the sides of a straight duct down the center of the room distribute air evenly along its length. In Fig. 2, grilles are located in offices as needed. Groups of offices located side-by-side are thus conveniently and efficiently served by straight duct sections. ▲▲

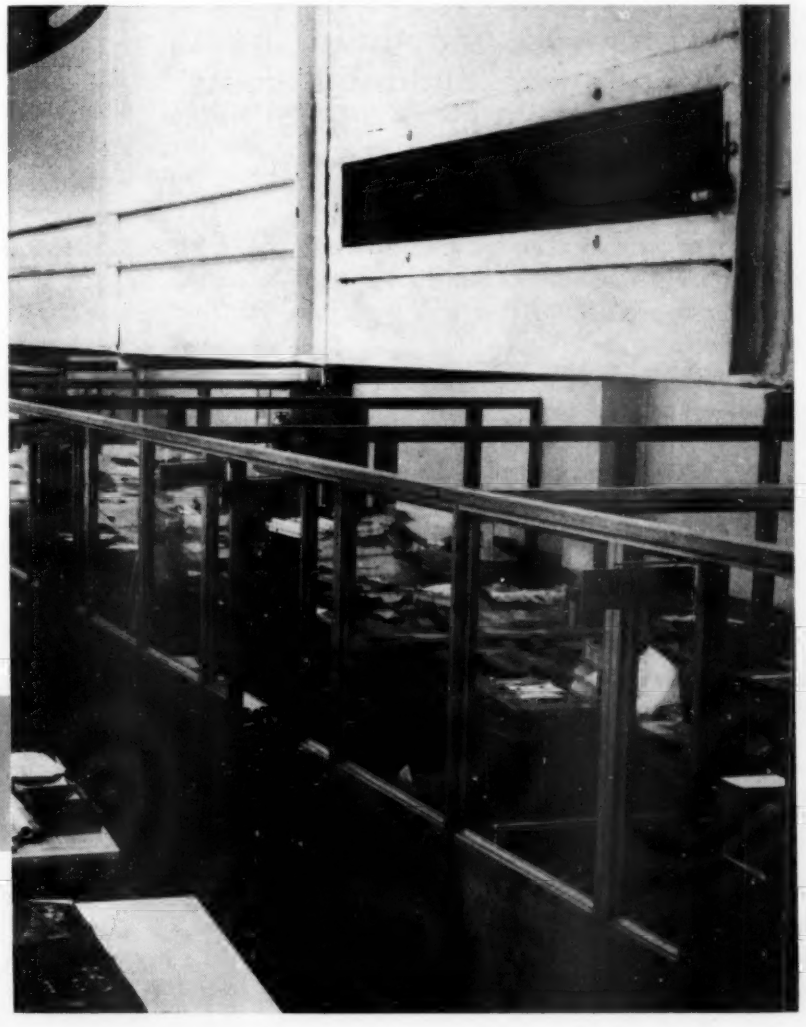


Fig. 2: *Private offices located side-by-side are conditioned through grilles in a straight duct section. Photo courtesy Surface Combustion Div., Midland-Ross Corp.*

For heating comfort that assures peak production, here's . . .

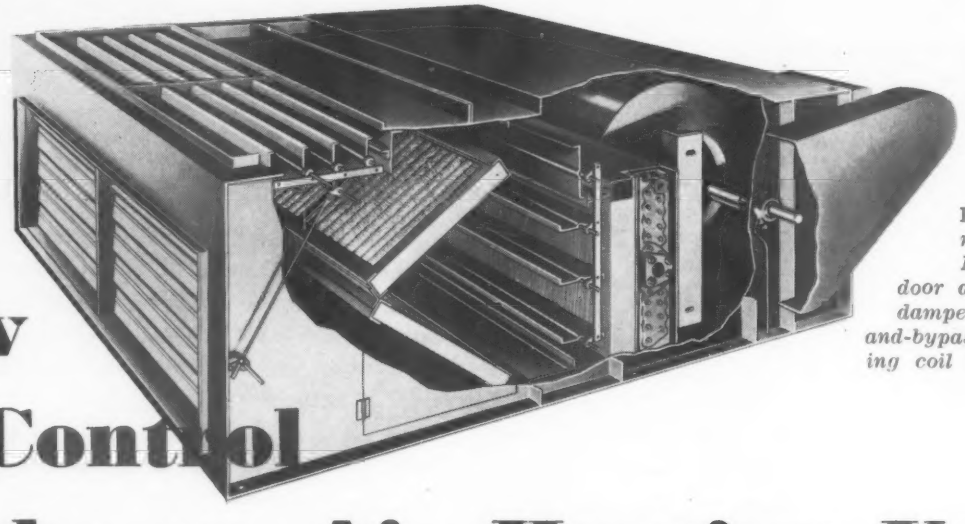


Fig. 1: *Typical make-up air unit. Left to right, outdoor and recirculating dampers, filters, face-and-bypass dampers, heating coil and blower.*

How To Control Make-up Air Heating Units

Proper control of make-up air heating units can assure draft-free distribution of air at desired temperature, freedom from coil freeze-up, maximum heating results at minimum costs. This article outlines principles of make-up air unit control.

by L. Burch
Vice President
V. L. Deppmann Co.

THE PURPOSE OF A FRESH AIR MAKE-UP UNIT is to supply tempered outdoor air to an enclosed space in order to replace air that is being exhausted from that space.

A basic fresh air supply unit or make-up air unit would consist of:

1. A fresh air intake
2. A means of heating the outdoor air in northern climates.
3. A fan to draw air through the intake and a heating device, and discharge it into the space at a constant temperature and sufficient rate.

Certain plants and processes might require additions to the basic unit such as special air cleaning devices in the intake; air washers or other means for accurate control of humidity within the space; means of cooling the air or dehumidifying it; and perhaps, a system of ductwork and air distribution devices to properly distribute air with a minimum of drafts throughout the space.

Unless the basic make-up air unit is to operate continuously, 24 hours a day, 7 days a week and 52 weeks a year, in, for instance, such an installation as a public utility power plant where make-up air is continuously required for combustion, there should

Fig. 1A: *Good make-up air heating practice is shown in this photo of the John Deere Industrial Equipment Works, Moline, Ill. Make-up air unit is at top left, with distribution duct brought down close to working zone.*

be a damper located behind the fresh air intake louvers. This damper will be open when the fan is operating and will close when the fan is stopped. Most make-up air units only operate eight hours a day, five days a week, so this damper is usually a "must." Basic make-up air unit is shown in Fig. 1.

If this make-up air unit is small, with perhaps a two, three or five horsepower motor driving the fans, we probably would not have to worry about opening the damper when the fan starts and closing it when the fan stops.

If, however, the unit is larger it would be dangerous not to open the damper first, because fans could possibly create enough negative pressure within the unit housing to buckle the dampers and prevent their opening.

There have been instances where the unit housing collapsed because a damper was not opened soon enough after the fan had been started. Opening the damper first can be accomplished by connecting the fan starter coil thru a relay to an auxiliary switch in the damper motor. Or a switch mounted on the damper can make contact to start the fan when the damper is open or nearly so. This method energizes the system by a switch which operates the damper motor, instead of a push button on the fan starter, as shown in Fig. 2.

Freeze Protection

The damper motor should be of the type that operates slowly, so as to help prevent coil freeze-up. Here's why. The basic make-up air unit usually handles 100 percent outdoor air. Heating coil steam valve is generally closed when unit is started. If outside air is below freezing, and damper opens too fast, blower will pull sub-freezing air over coil before steam valve has a chance to open and let steam into the coil in volume enough to prevent freeze-up. Coil will then freeze up, or the fan will be stopped by the freeze protection thermostat.

Even better freeze-up protection can be obtained by using a recirculating air damper. This type of unit will permit fans to draw first room air, then a mixture of room air and outside air, permitting the steam valve to open and fill coil in cold weather before the outside air damper is open wide, and unit is handling 100 percent outside air, as shown in Fig. 3.

Another advantage of a recirculating damper is that it prevents build-up of negative pressures within the unit casing which may either distort outside air damper or collapse unit casing. A make-up air unit with a recirculating air damper can also serve as a straight heating unit nights and weekends, when make-up air is not required. All you need do is add a switch to keep outside air damper closed at will, and install a night thermostat connected through the switch to start and stop the fan at a selected temperature, as shown in Fig. 4.

For larger units, there may be insufficient space

Fig. 2: *Fan is started from an auxiliary switch on the damper motor operator.*

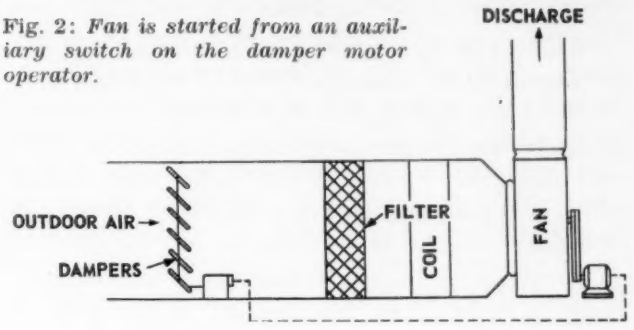


Fig. 3: *Make-up air unit using recirculated air for freeze protection.*

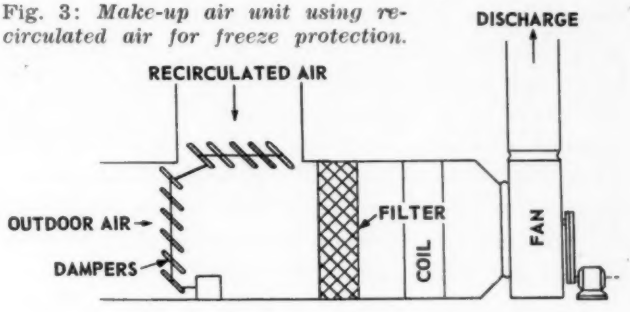
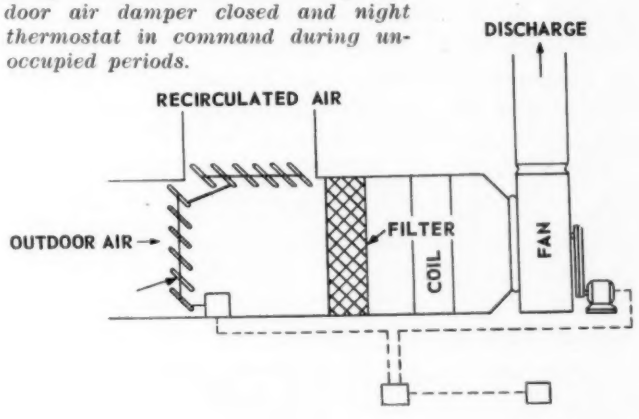


Fig. 4: *Unit with recirculated air damper, manual switch to keep outdoor air damper closed and night thermostat in command during unoccupied periods.*



for the right size recirculating air damper, or such a damper may prove to be too costly. In either case, coil freeze-up protection can be obtained by installing an outdoor thermostat which, when air temperature is below freezing, opens the steam valve as soon as the manual starting switch is operated. This set-up permits the coil to fill with steam as outside air damper opens. When both damper and steam valve are open, auxiliary contacts in both automatically energize a relay to start fan. After fan starts, relay or electro-pneumatic switch transfers control of steam valve to room or discharge air located thermostat, which modulates steam valve to its proper position with respect to demand of thermostat, as shown in Fig. 5.

For coil freeze-up protection when steam supply is not dependable, a pressure switch in steam supply line to unit can prevent fan from starting and outside air damper from opening when steam pressure is below safe coil operating limits, as shown in Fig. 6.

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Before leaving the subject of outside air dampers, it's important to remember that these dampers are not absolutely tight closing, because they are a series of free-operating louver blades. And even if the blades were tight, they form only wall of thin steel through which cold can easily pass by conduction. Conduction or leakage, results can be the same . . . a frozen coil.

For example, on one installation a large damper, about 12 ft. by 12 ft., was installed at the intake on the west wall of an upper floor. A bank of steam coils, controlled by a thermostat modulated steam valve, were installed about 18 in. behind the damper. Several large fans pulled outside air through these coils and discharged into reheat coils and ductwork. One Monday morning, after the system had been shut down for the week-end, (during which time outdoor temperatures had dropped to zero) it was found that coil bottoms, and some of the traps located between damper and coils, were frozen solid.

Freeze-up was due to a small leakage of steam through the double seat steam valve which was sufficient to meet demand of thermostat, which was located in the middle of the room and set at 50F. This small trickle of steam came in at coil top, and as condensate, condensed on its way to coil bottom, where it froze, due to air leakage or conduction through outside air damper.

Cure was a thermostat located near bottom of space between coil and damper, set at 40F and connected to take over control of steam valve, when damper was closed.

Good Piping A Control Aid

The best control set-up in the world can be no better than the system it controls.

For make-up air units to work correctly, even with proper controls, these recommendations should be followed:

1. Steam coils and modulating valves must be properly sized for heating load and available steam pressure.

2. Coils to be controlled by modulating steam valves must be kept free of condensate. Return system should be kept free of back pressures. Trap discharge should not lead into return line located above trap discharge, because when modulating valve is nearly closed, steam pressure in coil may not be sufficient to lift condensate up into overhead return line . . . and freeze-up may result.

3. On low pressure system, good practice dictates installation of vacuum breaker between trap and coil, because modulating valve produces a vacuum which will hold condensate in coil. This is particularly true of a single coil unit, which must be modulated over a wide temperature range. An open air relief in return system is good practice in any system not connected to vacuum return pump.

Fig. 5: *Control set-up shown here permits fan to start after the steam valve and damper are open.*

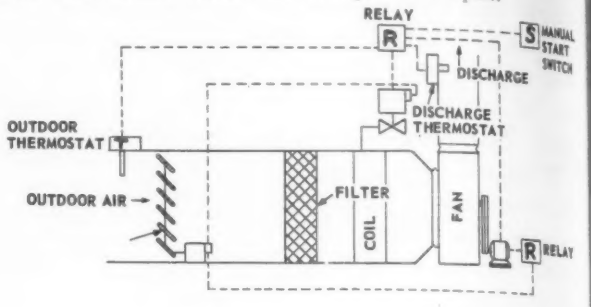
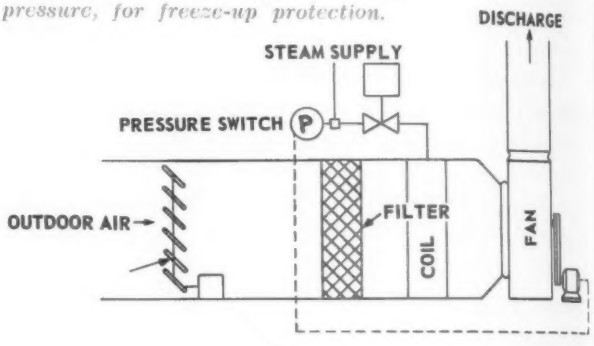


Fig. 6: *A pressure switch in the steam supply prevents unit operation in the event of insufficient steam pressure, for freeze-up protection.*



Modulating Valve Control

Modulating steam valves in steam supply line may be controlled in three ways:

1. From the room (Fig. 7)
2. From fan discharge temperature (Fig. 8)
3. From combination of room and fan discharge; that is, control from room thermostat with low limit control or submaster thermostat in fan discharge. Control by room thermostat permits unit to *cool* the room, which is often required even in cold weather because of high internal heat gains from manufacturing processes. Room thermostat senses need for decreased heat, throttles down steam valve, but permits make-up air unit fan to continue operating to bring in lower temperature outside air (Fig. 9).

A low limit or fan discharge control is required to prevent cold drafts from blowing on occupants. With room thermostat alone, modulating valve may overshoot and cause momentary blast of cold air to be blown into room. Low limit control senses air temperature leaving fan and can override room thermostat. Setting of low limit thermostat in fan discharge is usually about 10 degrees below level of room thermostat setting, unless internal heat gains are excessive.

Room thermostat control of modulating valve can be eliminated where rate of make-up air is very high, and required air delivery temperature is same as room temperature. In such applications, as in a paint spray room, control of fan discharge temperature only should suffice.

Fan discharge thermostat should modulate steam

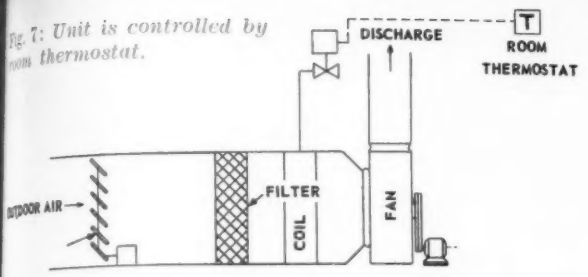


Fig. 7: *Unit is controlled by room thermostat.*

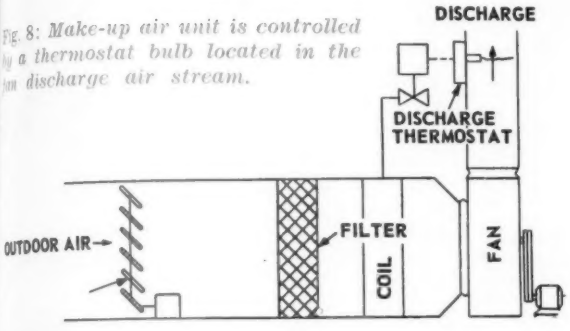


Fig. 8: *Make-up air unit is controlled by a thermostat bulb located in the fan discharge air stream.*

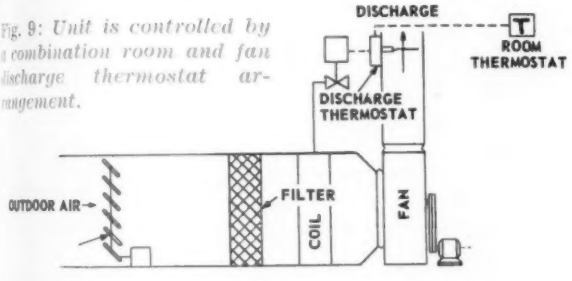


Fig. 9: *Unit is controlled by a combination room and fan discharge thermostat arrangement.*

valve within very close limits to maintain accurate temperature control of leaving air stream, because, as in the case of the paint spray booth, the men are working in a rapidly moving air current, which would be uncomfortable if constant temperature were not maintained within very close limits of required room temperature. Means of obtaining control within close limits are discussed in the following paragraphs.

Proportional Controls

An understanding of the operating principles of proportional controls is helpful to their correct application. A proportional control is designed to provide increment control to match variations in room temperature. These instruments (thermostats) have a built-in "modulating range," "throttling range" or "droop." For convenience, we will use the word "droop," which is the amount of room temperature change required at the thermostat to operate the steam valve all the way from wide open to closed position.

Most control situations would require a proportional thermostat with a minimum of 10 degree droop, and often more, to permit stable control and eliminate "hunting" by the steam valve. However, droop will cause under or overheating, if not compensated for.

A droop of 10 degrees means that fan discharge temperature must change by 10 degrees to cause steam valve to move from wide open to closed position. If thermostat is set at 70F and outside temperature is 35F, steam valve would be half-way open (if properly sized). If outside air temperature drops to zero, from 35F, with thermostat set at 70F, one-half the droop, or 5 degree drop at thermostat would be necessary to open the steam valve to wide open to handle the zero temperature. Thermostat would then control at 65F instead of 70F and make-up air unit would deliver 65F air. If outdoor temperature were 70F, valve would be nearly closed and control point of thermostat would shift five degrees in the other direction so that 75F air would be delivered.

Droop can be compensated for by an "outdoor reset" device. Simplest form of such an instrument is a dual bulb proportioning thermostat, with one bulb in outside air intake, and the other bulb in the fan discharge.

Another such device is a master and submaster reset control, with the "master" thermostat in outdoor air resetting control point of submaster thermostat in fan discharge enough to overcome shift of control point caused by "droop."

Two Valves Better Than One

Another control improvement for a single heating coil is the use of two valves instead of one, as shown in Fig. 10. Two smaller valves, with one sized to handle about one-third of the load, and the other sized to handle remaining two-thirds, will give better results, because of improved system turn-down ratio. (See Fig. 3.)

Turn-down ratio is the amount the steam valve can reduce heat output of coil without entirely shutting it off. This amount is the ratio of maximum heat output to minimum heat output . . . or the turn-down ratio of the valve.

For example, a valve having a turn-down ratio of 20 to 1 means that steam flow can be reduced to within five percent of maximum flow. From this position to fully closed position, changes in valve stem position have little or no effect on steam flow until valve is fully closed. Use of two sequentially operating smaller valves in place of one larger valve thus gives improved temperature control by permitting more accurate steam flow regulation through better turn-down ratio . . . a more precise relationship of heat output to space heating requirements in mild weather.

Steam distribution type coils lend themselves to good control because temperatures across the coil are more even under all degrees of steam flow modulation. The thermostat bulb located near center of coil, or in discharge of center fan of long multi-fan unit,

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will register nearly average temperature conditions of air being drawn through a long coil of the steam distributing type.

Stratification of coil temperatures, even on steam distributing tube type coils, can be considerably reduced by having supply and return connections at opposite ends of the coil.

Two Coils Better Than One

Two coils, of the steam distributing tube type, give improved temperature control. These coils are generally called preheat and reheat coils. The first, or preheat coil, is often controlled by a two-position, on-off control valve in steam line, actuated by thermostat in outside air stream set at 35F. This method is supposed to protect against coil freezing. That it will do so is open to question; besides, this control method can lead to serious space overheating.

For example, where outdoor design temperature is -10F, preheat coil should be sized to heat outside air from -10F to 35F. If at 35F the two-position valve opens on demand of outdoor thermostat, preheat coil would raise air temperature 45 degrees. Adding a 45 degree rise to 35F air means we supply 80F air to the space from the preheat coil alone, which may cause overheating.

A better method of controlling a make-up air unit with preheat and reheat coils, with bulb in fan discharge, is by means of a reversing series control with two modulating valves, as shown in Fig. 11. One valve is installed on each coil, and arranged so that the preheat valve must be wide open before reheat valve can start to open and reheat valve must be fully closed before preheat valve can start to close. If preheat coil has opposite end supply and return steam distributing tubes and steam is supplied to heat the air to 60F or 65F from 32F or less, there is little danger of coil freeze-up.

Use of a freeze protection thermostat, with its thermal element placed in the airstream at the downstream side of the heating coil, should perhaps be discussed at this point. A thermostat so located to be of any great value in the way of freeze protection must be of the extended type (20 ft. to 25 ft. long) with the thermostat responding to the lowest temperature sensed by any part of its element. The reason for this is that most coil freeze-ups take place or start in some small area of the coil. A thermostat must, therefore, sense and act to stop the supply fan when air passes through any area of the coil face and which has not been heated to at least 35F.

This sounds like a large order, and is, in the case of a bank of several coils in a large fresh air make-up fan system. Probably more than one freeze protection thermostat would be required to fully protect a bank of several coils. The most probable points of freeze-up on any coil, and the areas in front of which a freeze-up thermostat bulb should always be placed, would be the end of the coil opposite the steam supply and along the bottom row of horizontal tubes when the coil is on edge.

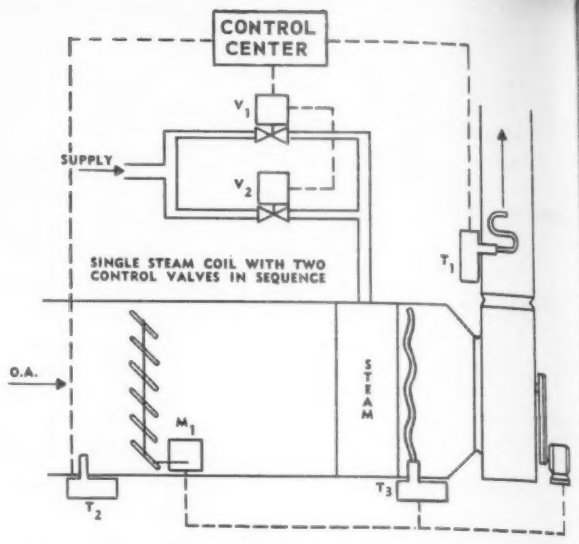

Fig. 10: *Typical make-up air unit with single steam coil controlled by two motor-operated steam valves in sequence.*

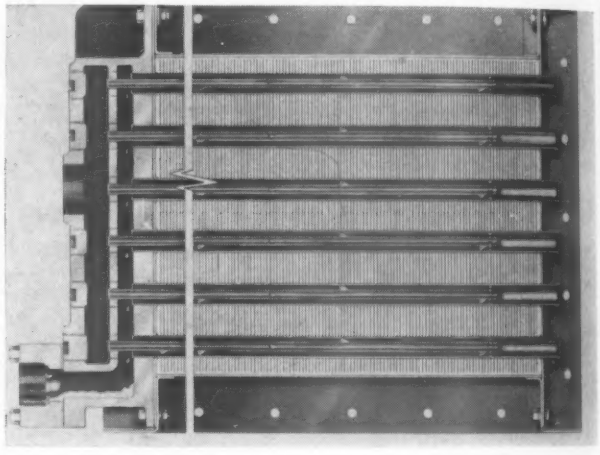

Fig. 10A: *Steam distributing type coil. Steam enters header, goes through tube-within-a-tube and out inner tube jets. Condensate is forced rapidly to coil outlet, steam continuously wipes coil interior surface for maximum heat transfer efficiency. Although supply and return headers are on same side of coil, effect is that of opposite end headers.*

In the case of a unit with preheat and reheat coils, the freeze protection thermostat element must be placed in the air stream on the downstream side of the preheat coils, (which would be between the preheat and reheat coils) in order to afford any real protection to the preheat coil.

This means that there must be some space allowed between the two coils in order to properly install the thermal element. Few manufactured units provide space between the two coils and an access to that space for the proper installation of a thermal element in the air stream in order to protect the preheat coil.

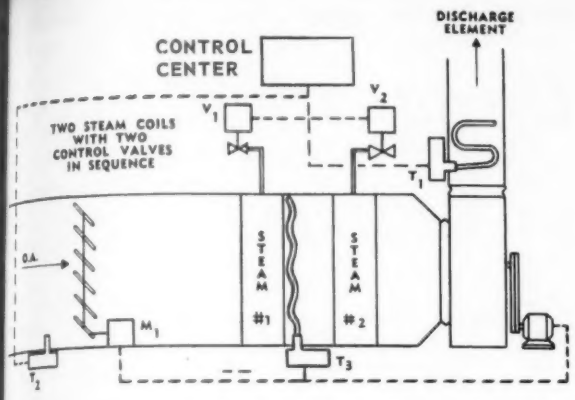

Fig. 11: Typical unit with two steam coils and two control valves in sequence.

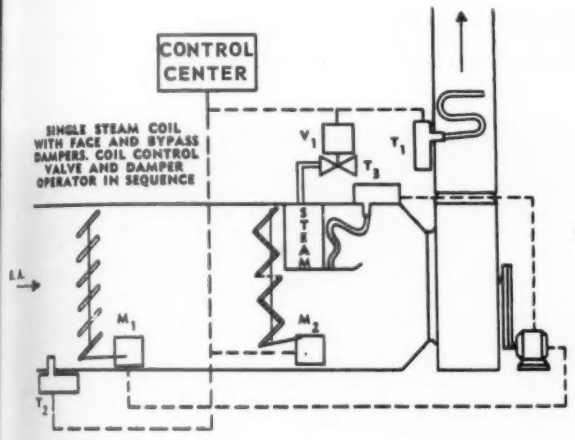

Fig. 12: Unit with single steam coil and face and bypass dampers. Coil control valve and damper operate in sequence.

The moral is that if you want to protect a preheat coil with an air stream thermostat you will have to first obtain a unit that is built so that one can be properly applied to it.

Face And By-Pass Dampers

The usual reason given for using face and by-pass dampers in fresh air make-up units is to provide adequate protection against freezing. Actually, a unit with a steam coil and face and by-pass damper can freeze as easily as one without face and by-pass dampers if the steam supply is insufficient, if the trap fouls or if for any other reason the condensate flow is retarded.

If the face and by-pass damper by itself could be depended upon for complete control of temperature, we would have a satisfactory answer for the installation which we previously discussed, where the return main was located above the trap and the steam pressure had to force the condensate up to the higher level. In this case our thermostat or combination of thermostats would control a damper motor actuating our face and by-pass dampers, to allow part of the

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PICTURE CREDITS

All drawings showing control systems, courtesy Barber-Colman Co., Rockford, Ill. Photos in Figs. 1, 1A and 10A, courtesy The Trane Co., La Crosse, Wis.

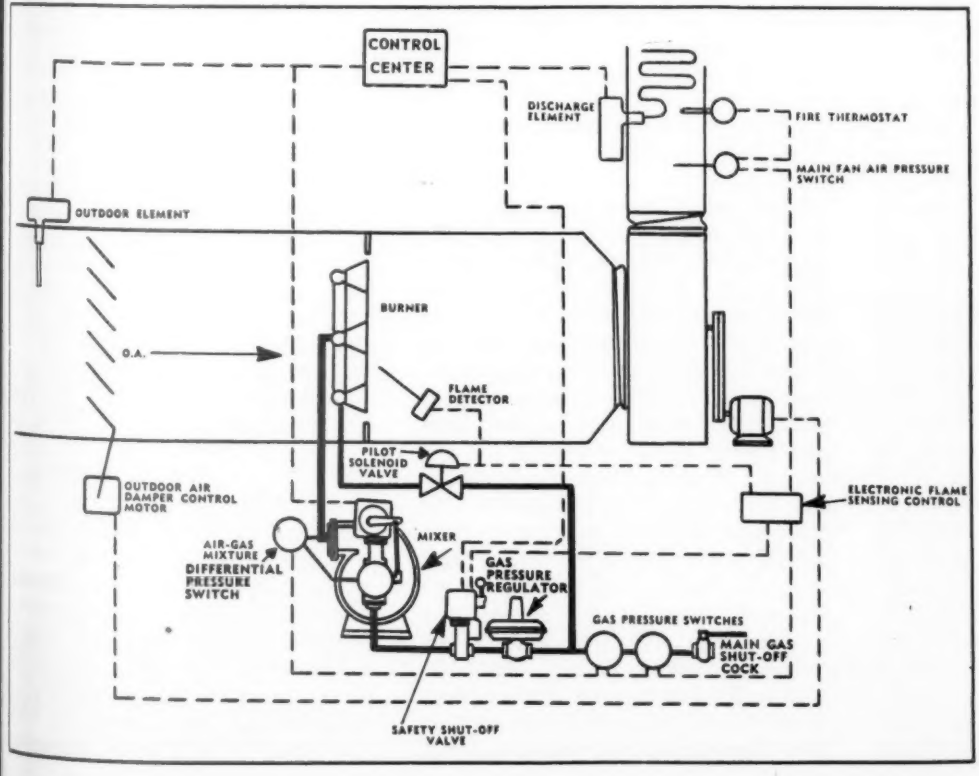

Fig. 13: *Direct-fired (gas) 100 percent outside air make-up unit with control system.*

Fig. 1: *Hood of sheet metal and plastic is installed over this beryllium lathe operation. This arrangement consists of chip collecting suction head on tool stock and fixed position hood. Chip pickup is at 5000 fpm in throat, at 170 cfm; hood is 125 to 200 fpm at work, at 330 cfm.*

A primer on . . .

Practical Ways to Collect Beryllium Dust

PART II

by A. J. Breslin and W. B. Harris
Health and Safety Laboratory
U.S. Atomic Energy Commission

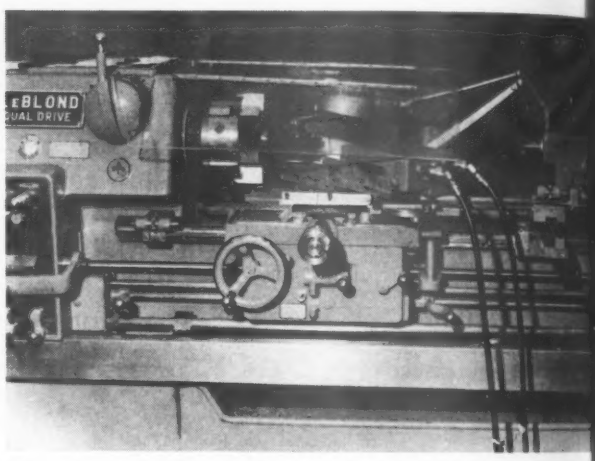

Fig. 2: *Secondary enclosure on turret lathe is of clear plastic. Hood has volume rate of 200 cfm. See Fig. 1 for a view of the chip pick-up on this lathe operation.*

Here is exhaust ventilation system design data for beryllium operations involving manual operations, batch automatic and automatic unattended processes. Data includes hooding for lathes, blenders, ball mills and rotating kilns.

LAST MONTH, GENERAL PRECAUTIONS in the use of beryllium and a summary of methods of its dust control was presented. This issue, Part II, gets more specific as to the engineering aspects of control of this highly toxic substance.

Local Exhaust Ventilation

Careful process design and arrangement can minimize and simplify ventilating hoods and minimize the ventilating air capacity; it cannot eliminate the need for local exhaust ventilation. This is because air concentrations in excess of the stipulated maxima can be produced by extremely small quantities of contaminant.

Essentially every process step must be provided with some degree of local ventilation. It is sometimes difficult to comprehend the fact that even processes which appear absolutely free of contamination nonetheless may be sources of significant concentrations. To cite an example, an average concentration of 11 $\mu g/M^3$ was measured in the close proximity of a man separating steel balls with a hand magnet from a container of soaking wet beryllium pebbles.[2] The operation was not ventilated. The 11 $\mu g/M^3$ can be definitely attributed to this specific operation because the average air concentration in the area was 1.6 $\mu g/M^3$. One might wonder by what means the contamination became airborne, yet it was there. General room ventilation cannot be expected to provide satisfactory control for specific dust sources.

COMPARISON OF MAC'S OF SOME METALS AND BERYLLIUM

Metal	Mg/per cubic meter
Zinc oxide	15.0
Lead	0.2
Mercury	0.1
Beryllium (in plant)	0.002
Beryllium (outdoors)	0.00001

Indeed, general ventilation improperly applied can add to the problem of control by dispersing dust which may have settled on floors and work surfaces. Specific data regarding this phenomenon were obtained at a plant where unit heaters were used to warm the production area.[3] Successive

st samples were collected alter-ely with the heater blowers on d off. The concentrations were nd to be greater by a factor of o with the blowers on.

The basic principle of control is contain and remove dust at its urce. Local exhaust ventilation ll do this provided that hoods d air volumes are properly se-ected. Hood types of a wide variety ve been employed successfully in e many facilities observed, rang-g from small laboratory appara-s to large production units.

Because of the variety of equip-ent used at beryllium operations d the variation in operating re-irements for the same piece of uipment at different facilities, it impractical to try to design a iversally applicable hood. The pe used for each operation must selected on the basis of good t control plus operating and intenance requirements. But a sideration which should not be lected, particularly in larger plants, is the total exhaust air capacity.

Recognition of the extent to which ventilation must be applied because of the multiplicity of even small points of exhaust indicates that the efficient use of air capacity can be an important economic factor. Thus, the selection of hoods with optimum performance on an air capacity basis is a desirable objective. Therefore, adequate dust control, ease of operation and maintenance, and optimum utility of exhaust air should all be given proper weight.

Before discussing specific types of local exhaust control applications, a few general observations may be made. Experience with a variety of hoods leads to the following recommendations:

1) With rare exceptions, dampers should not be designed to permit adjustment by operators. Dampers are not recommended.

2) Where frequent access is required, encumbrances should be minimal.

3) Simplicity is desirable. The less manipulation by the operators is required, the greater is the prospect of proper hood use.

4) Designs should be conservative.

In describing the kinds of hoods and their particular characteristics as applied to specific plant and laboratory equipment, it is convenient to consider four, perhaps arbitrary categories of operations.

1) *Manual*—Small, purely manual equipment requiring continual access while in use: machine tools, sorting, weighing, metallography, etc.

2) *Batch automatic* — Larger, semiautomatic, generally requiring intermittent access to introduce or withdraw process material and to adjust equipment: blenders, furnaces, filters, batch centrifuges, ball mills, etc.

3) *Automatic unattended*—Essentially self-operating, requiring little or no access except for maintenance: rotating kilns, continuous feed centrifuges, automatic conveyors, storage bins.

4) *Material transfer* — This is involved in the first two categories above, but it is important enough for separate discussion as a fourth category.

Manual Operations

Operations involving continual manual manipulation are, with only a few exceptions, most effectively

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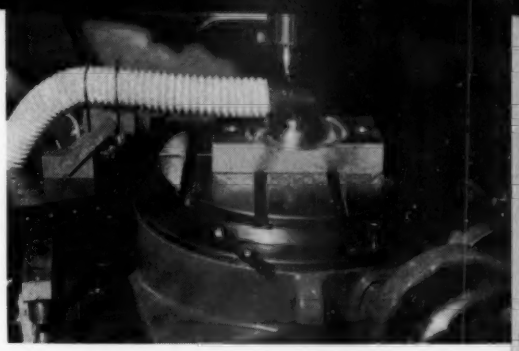

Fig. 3: *Jig boring operation has a flexible tube that picks up metal dust and chips as soon as formed. Control is satisfactory since particles possess practically no kinetic energy. Air volume rate is at 200 cfm.*

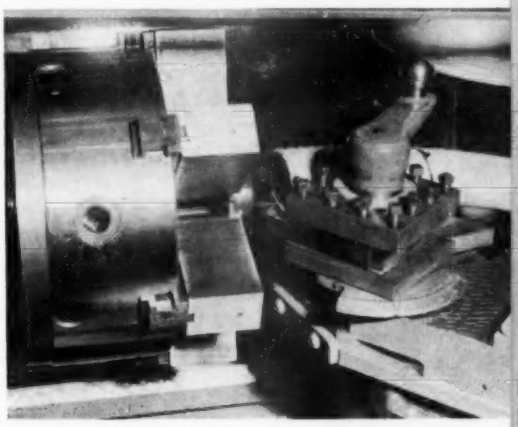

Fig. 4: *This is same operation as shown in Fig. 2. Note flexible tube chip pick-up, which is the only source of suction. Air volume rate is 200 cfm. Lathe is used for volume production work.*

Fig. 5: *Mixing tank containing mostly beryllium hydroxide. No hood is provided, although there is an exhaust connection for negative pressure. Fpm is about 150, air volume rate is 300 cfm. Air capacity is designed for 150 fpm indraft when access door is open.*

About The Authors

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Alfred J. Breslin is Chief, Field Services Branch, Environmental Sciences Division, U. S. Atomic Energy Commission. He has participated in planning, coordinating and administering the investigation, evaluation and control of radiation and toxic hazards in and around facilities operated by and for the Atomic Energy Commission. He holds an M.E. degree from Stevens Institute of Technology.

(Continued from preceding page)
and economically controlled by completely enclosing hoods provided only with those openings necessary for operational access. Hinged or removable panels may be provided for occasional maintenance. A positive inflow of clean air at the hood openings minimizes the escape of dust into the general atmosphere. A few rules have general application to enclosing hoods:

1) The size of the hood openings must be made as small as possible, consistent with reasonable accessibility, to prevent the escape of dust and for most efficient use of ventilating air.

2) Hoods must be designed so that a man need never place his head inside during normal operation.

3) Air velocities at hood openings should be 150 fpm or greater. Where the operation being controlled imparts a high kinetic energy to the dust particle or where external air turbulence is great, correspondingly greater hood face velocities are needed.

Relatively small pieces of apparatus such as bench grinders, pulverizers, sieves, weighing scales, tampers, and small blenders and mills can usually be conveniently and effectively ventilated with enclosing hoods. Other fully manual (nonmechanical) operations, such as picking and sorting and special jobs, are also best controlled in this manner.

It is often desirable to group several small machines or operations in a single bench booth, such as a chemical hood. This is particularly effective when three or four machines are to be used successively in the process. In this case, their physical proximity represents a saving in time, space, and ventilation capacity. A very definite advantage to this arrangement is that the transfer of material from one piece of apparatus to the next may be done within the hood. It is also practical and simple to retain tools under the ventilation. Ventilation is inherent during handling and no special equipment need be devised.

Hoods of this type may be of any size; a width of 10 to 15 ft. is not infrequently encountered. Since the rate of exhaust air will vary with the size of the hood openings for a given design velocity, these should be minimized in the interest of economy. An operating opening 6 to 8 in. high along the hood face usually provides ample access. The opening may be diminished by the addition of sliding panels to allow access to only a portion of the hood enclosure at a time. This will reduce ventilation requirements and induce more methodical operation. The upper part of the hood face may be permanently covered with glass or transparent plastic for visibility.

The unique qualities of beryllium extend even to the manner in which it machines. It has several unusual properties, the combination of which causes it to generate potentially dangerous quantities of dust when it is worked. Not the least of these, of course, is its very low allowable concentration.

The material does not cut easily, requiring special, well maintained tools. It is very friable, forming a small broken chip along with considerable fine dust. The use of coolant helps only slightly. It should be noted, however, that these properties are those of the unalloyed metal and do not apply to beryllium-copper or other alloys.

The ventilation of machine tools warrant special consideration. Generally they cannot be properly operated if too much restriction is enforced on the operator. Totally enclosing hoods may often be unnecessarily cumbersome and for many tools they are not needed. A very useful control method is the combination of a high-velocity chip pickup at the cutting tool and a secondary partial enclosure, as shown in Fig. 1. This has been applied to lathes with particular success. If the pickup can be designed essentially to surround the source of chips without operational interference, as in the case of milling or drilling, the enclosure may be eliminated, as shown in Fig. 3.

High-speed abrasive tools have generally required complete enclosure. Surface grinders, centerless grinders, and cutoff wheels require this treatment.

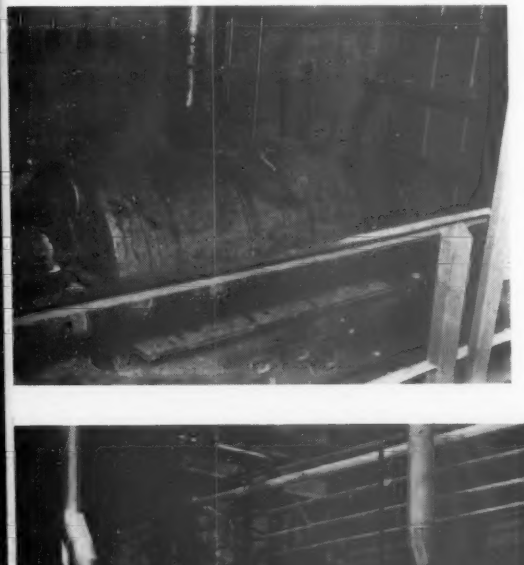


Fig. 6: *In this centrifugal separator, protection is provided by negative pressure at volume of 250 cfm. Process material is ammonium beryllium fluoride (crystals). Ventilation maintains negative pressure inside the centrifuge casing. Guard over drive shaft prevents leakage from being sprayed into the air.*

Batch Equipment

Batch equipment may include certain ball mills, blenders, tanks, reactors, furnaces, filters, and some kinds of centrifuges. No firm line of distinction may be drawn between this category and the last,

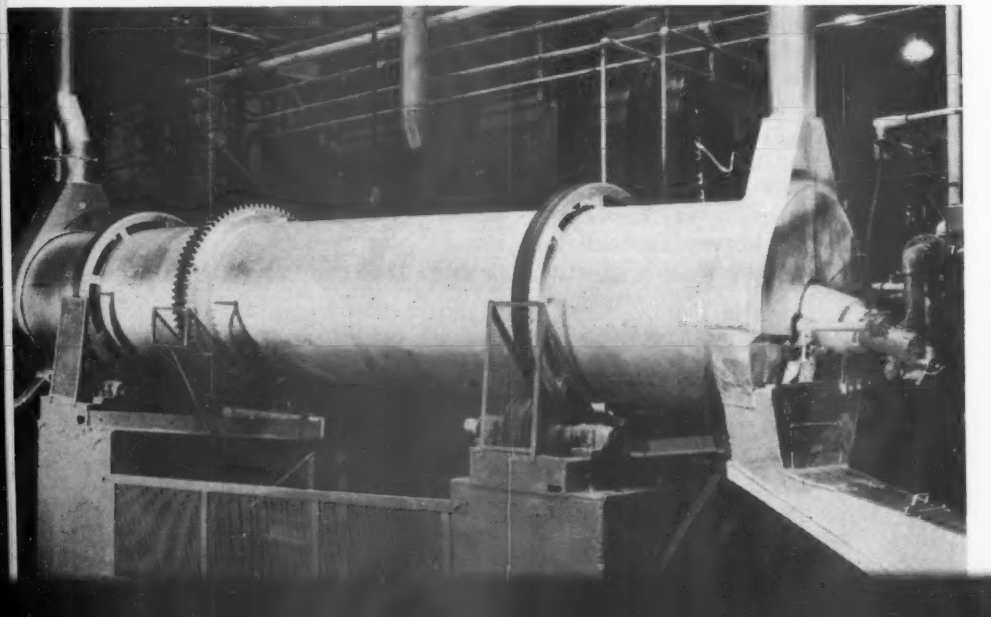


Fig. 7: *Rotating kiln is used to process fused beryl. Hood is of sheet metal and has air volume rate of 320 cfm at feed end and 375 cfm at dish end. Both ends of kiln are ventilated. The chute under near end of the kiln terminates at the boot of a bucket elevator which is also ventilated.*

these items by virtue of their would not be included in the usual category. The important characteristic of batch equipment with regard to dust control is the necessity to charge and withdraw material for each process cycle, i.e., transfer of material. Many of these devices present no significant contamination problem while in operation because they are effectively sealed.

An obvious way to overcome the transfer difficulty is to devise an automatic charge and/or receiver system. This has been done successfully for a few batch operations. One example was an oxide furnace gravity fed from an overhead hopper, which was in turn fed by a pneumatic conveyor. Withdrawal of the fired oxide was accomplished manually by the ingenuous combination of a ventilated transfer cart and pneumatic conveyor system. The pneumatic suction line was manipulated manually from outside the furnace enclosure and was never withdrawn from the hood.

The use of hopper feeds is quite common. For use in connection with rotating batch equipment, the valving arrangement must be carefully designed for minimum leakage and positive cutoff. Almost invariably, ventilation is necessary.

Wet batch reactions pose no difficulties where the process material can be pumped through pipelines in and out of the mixing or reacting tank. The escape of vapor or mist can be prevented by applying a suitable exhaust to the tank, as shown in Figs. 5, 6 and 7. Here again it is interesting to note that exhaust is in fact required; unventilated wet process equipment may normally be expected to produce concentrations above permissible. The air capacity should be sufficient to create an indraft velocity of 50 to 150 fpm through access covers or a slight negative pressure if the vessel is normally sealed. Extra capacity may be required if the reaction is violently exothermic or when access is required during operation.

Usually, however, the batch operation involves filling and dumping. The effectiveness of the control applied will depend on the care with which ventilation and baffling are designed for the dumping and filling operations.

Two approaches to hooding for batch devices have been used successfully. The first, where size permits, is to enclose the unit completely, with provision in the enclosure for access to charge and discharge and to make adjustments, Fig. 10. Hoods of this type may often be very simple rectangular boxes with access doors or panels suitably placed. The second method is to apply exhaust at each point in the equipment where dust may be emitted, This requires a more skillful design with proper control velocities to insure capture of the escaping dust. Each type offers advantages; their characteristics are listed in above table.

In many cases a combination of the two hoods is necessary. The large box type of control permits precipitation of material on the inside, and serious maintenance problems can result. The combination hood which provides reasonably good local pickup at the source of generation, backed up by an enclosure insuring secondary control to cover inefficiencies in the primary, and also to accommodate occasional bursts or failures, is frequently necessary and highly effective.

(Please turn to page 51)

EXHAUST SYSTEM CHARACTERISTICS

	Box	Tailored Fit
Design:	Simple.	Requires skillful application.
Control:	Reasonably positive.	Depends on design.
Accessibility:	Sometimes inconvenient.	Generally good.
Housekeeping:	Contamination contained; generally accumulates.	Self cleaning if properly designed.
Material transfer:	Containers require cleaning prior to removal.	May be more or less foolproof depending on design.
Economy:	Usually efficient and inexpensive.	More costly; uses more air.

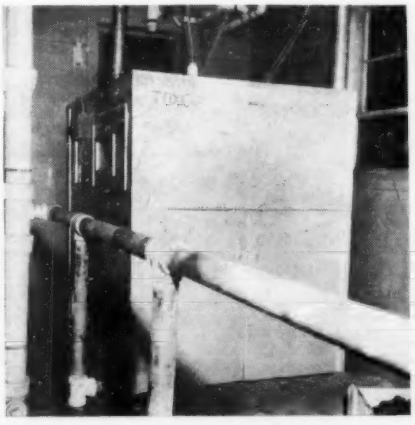


Fig. 8: *Jaw crusher pilot plant has hood of plywood over operation. Feed door has 450 fpm; receiving drum door (shown open) has 125 fpm. Air volume is 900 cfm. Beryl is process material. Access doors are provided for feeding material to the crusher and for changing the receiver drum. Only one of the larger doors need be opened to effect the latter operation.*

Fig. 9: *Below, extruder and electric furnace pilot plant processing beryl and graphite has hood of plywood and glass. Velocities are about 250 fpm and air volume is about 350 cfm. Internal hooding is not provided. Access doors are suitably located to install and withdraw process material.*

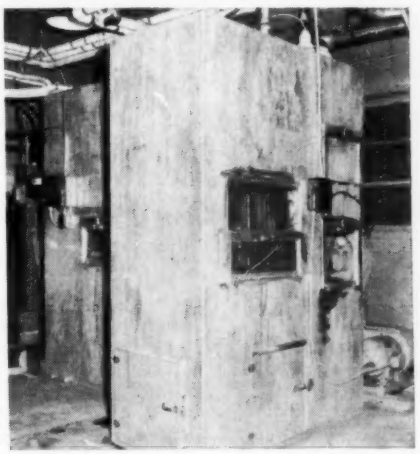
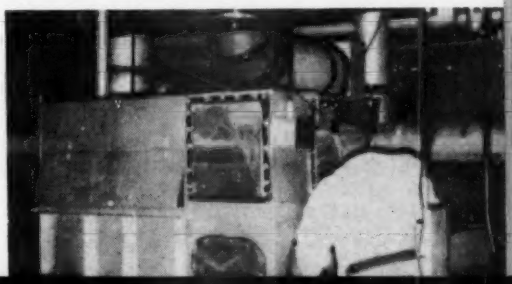
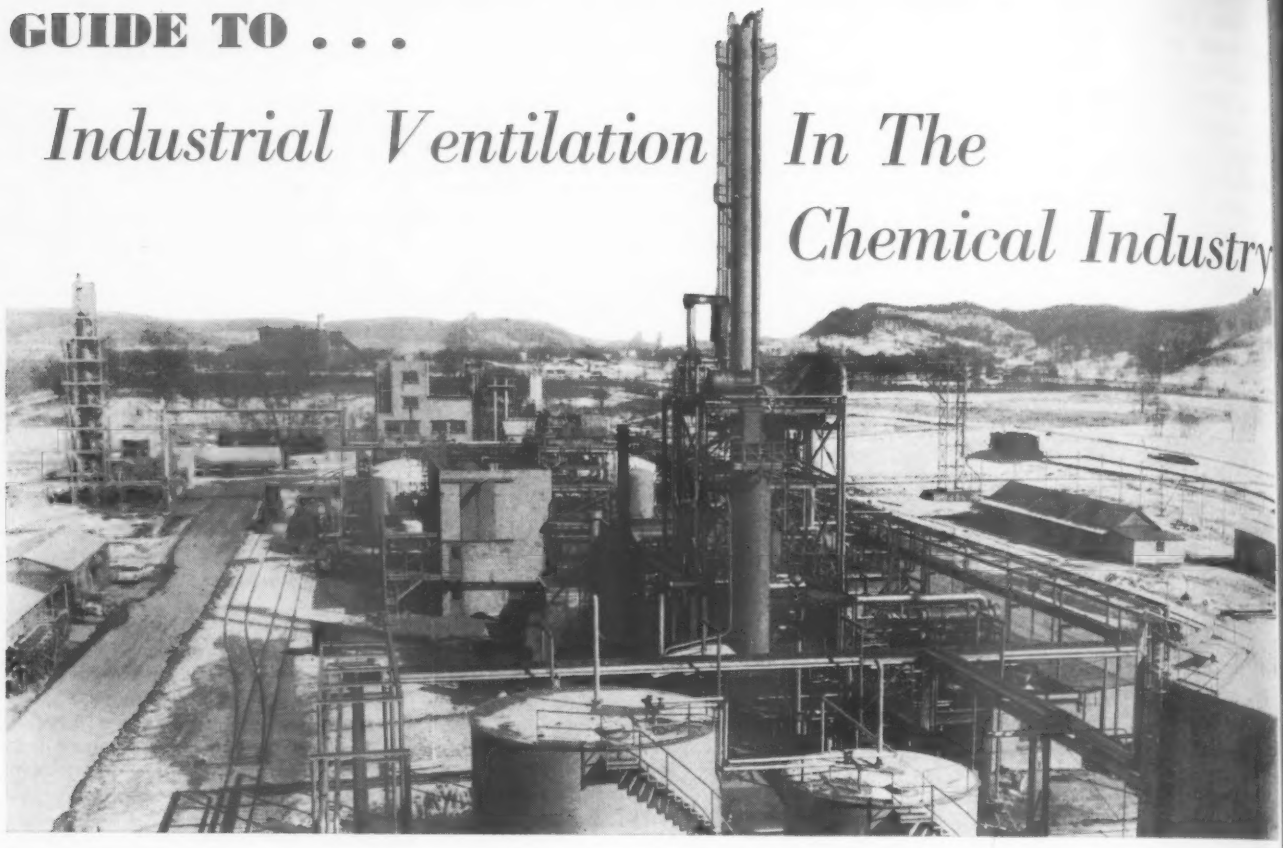


Fig. 10: *Below, semi-production jaw crusher processing beryllium oxide has hood of sheet metal and glass. Velocities are about 200 fpm; air volume at 1500 cfm. Hood ventilates feed end of jaw crusher used on fused beryllia. Drum containing chunks of beryllia is introduced horizontally with lid fastened, into the compartment at left of operator. Lid is then taken off drum but left in compartment. Top door to compartment is left slightly ajar to maintain a positive inflow of air past the drum into crusher feed compartment from which the ventilating air is exhausted.*



GUIDE TO . . .

Industrial Ventilation In The Chemical Industry



View of American Cyanamid Co.'s new aniline manufacturing facilities at Willow Island, W. Va. Plants such as these require careful design of ventilating systems to maintain employee health.

By William V. Andresen
Chief Industrial Hygienist
American Cyanamid Co.

Wherever a chemical reaction takes place in a pressurized vessel, or where chemicals are mixed or blended, there's a ventilation problem. Here are the solutions to these problems.

REACTION VESSELS of various shapes, sizes and materials of construction are used in industry for a multitude of purposes.

In the utilization of these vessels, operators may be exposed to toxic or irritating gases, vapors, dusts or mists. These are liberated or created during operations such as charging, sampling, testing, boiling, mixing and reacting.

Hood enclosure and local ventilation is the best method for controlling the emissions of gases, vapors, dusts and mists.

Much has been written concerning ventilation control measures for solvent degreasing tanks and other open tank applications. Therefore, no further discussion of open tank ventilation will be made.

The discussion will deal primarily with control measures as applied to vessels used for solution, mixing, blending and chemical reaction.

Ideal tank operations would be performed in closed equipment and would not require ventilation. Unfortunately, it is necessary to perform many process operations with the tank manhole or a portion of the tank open.

Many tanks, tubs, and kettles are equipped with covers and where feasible, the cover should be tight. In the interest of ease of control, the tank should have an opening just large enough to permit the charging of material and other operations which must be performed. The size of the opening may be limited by being large enough to allow the easy entry of a workman for maintenance purposes. It is not always possible to cover a tank tightly. For instance, it is difficult to get a tight wood cover on wood tanks. Other tanks have more than one opening to accommodate pipes, chutes, etc. Chemical reaction kettles

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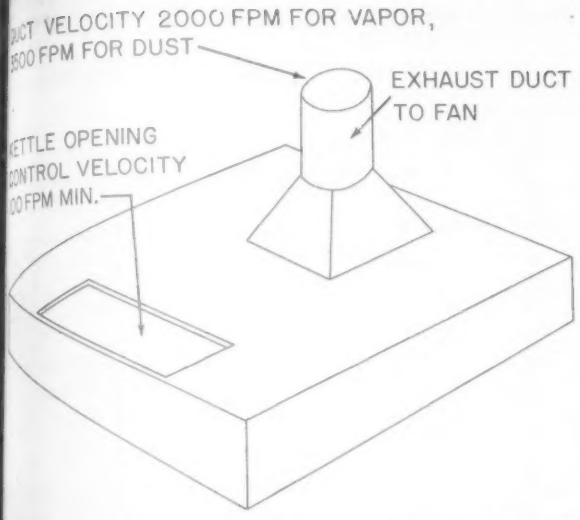

Fig. 1: *Draw-through ventilation application, showing exhaust duct connected directly to cover of reaction vessel.*

which operate under pressure or vacuum are, of course, covered and equipped with a manhole and special nozzles for pipe connections.

Gravity stacks (natural draft ventilation) may be utilized to provide the air volume necessary to contain and control the toxic materials from reaction vessels in some cases. Natural draft ventilation can only be used if the operation is hot and there is a substantial temperature difference between the air in the stack and the room air.

Formulas for the calculation of the static pressure developed in natural draft stacks can be found in many standard reference books. From the static pressure and the volume of air required for control, the air velocity and the stack diameter may be determined using other formulas in references on the subject.

A control volume of 100 fpm across the tank opening is generally used. However, if a substantial volume of material is evaporated from the tank, an equivalent volume in cfm to that evaporated should be added to the air volume calculated for control. The stack diameter should be sized using the combined air volume.

Static pressures developed in gravity stacks are very low and therefore large stack diameters are required to exhaust the required control volumes.

Ejectors powered by air, steam or water may also be used to provide the air needed for control purposes in the operation of tanks, tubs and reactors. Formulas for ejector design are available in standard references. The ejector is extremely inefficient and should be used only for short period intermittent operations or when sticky or corrosive materials are to be controlled.

Mechanical exhaust fans of either centrifugal or axial flow design along with suitable hoods will provide the most effective and economical means of control for reaction vessels.

Three general hood and ventilation methods may

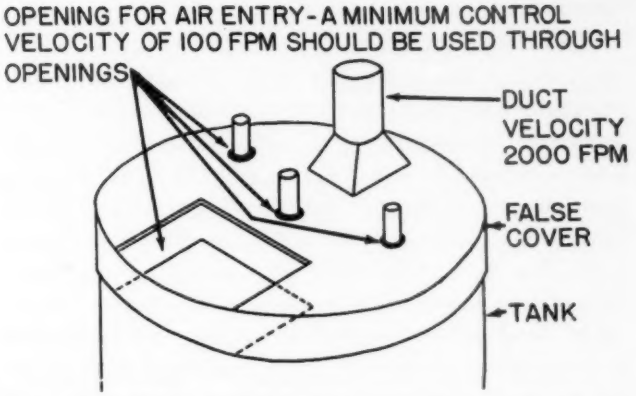
OPENING FOR AIR ENTRY - A MINIMUM CONTROL VELOCITY OF 100 FPM SHOULD BE USED THROUGH OPENINGS
DUCT VELOCITY 2000 FPM
FALSE COVER
TANK

Fig. 2: ***Modified draw-through ventilation that can be used where volatile solvents are processed in tanks with many openings.***

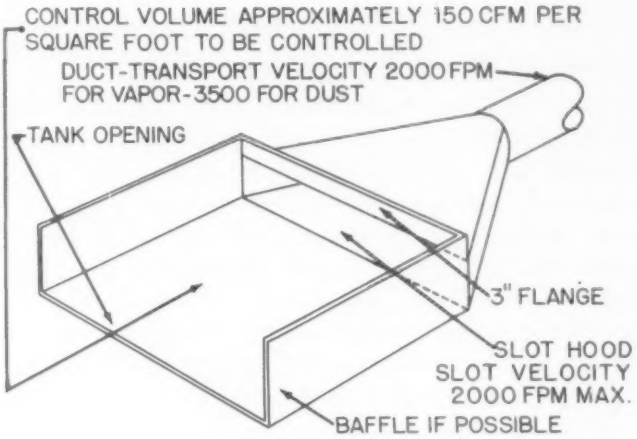
CONTROL VOLUME APPROXIMATELY 150 CFM PER SQUARE FOOT TO BE CONTROLLED
DUCT-TRANSPORT VELOCITY 2000 FPM FOR VAPOR - 3500 FOR DUST
TANK OPENING
3" FLANGE
SLOT HOOD
SLOT VELOCITY 2000 FPM MAX.
BAFFLE IF POSSIBLE

Fig. 3: *Slot for square opening when slot hood ventilation is applied.*

be used to provide control of airborne contaminants from reaction vessels. They are –

1. Draw-through ventilation.
2. Slot hood
3. Hood enclosure.

Gravity stacks and ejectors are generally used in conjunction with draw-through ventilation. Mechanical exhaust fans are used for all three types of ventilation systems.

Draw-through Ventilation

Fig. 1 shows how draw-through ventilation is applied. An exhaust duct is attached directly to the cover of the reaction vessel and all control air is drawn into the tank openings. This type of ventilation is most effective when the cover of the vessel is not tight or if there is more than one opening in the cover. Satisfactory control can usually be realized by exhausting an air volume equivalent to 100 cfm per sq. ft. of tank opening. However, if large volumes of material are evaporated from the kettle, an equivalent air volume in cfm should be added to the volume calculated for control.

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Draw-through ventilation is effective as a control method but has a number of drawbacks. Since the principle of control is to contain gas and vapors within the kettle, the control of contaminants outside of the kettle created by such operations as charging of solids from drums or bags is not good. Excessive loss of solvent materials and decreased product yield may occur due to the fact that all exhaust air has been drawn into the tank and across the surface of the liquid, tending to increase evaporation. Excessive loss of solids charged through the manhole may occur as the solids are dumped directly into the control air stream. Solids exhausted along with steam in draw-through ventilation have been known to cause frequent duct blockage. There is a possibility that explosive mixtures of solvents may be created in the kettle and ductwork by the draw-through system.

Modified Draw-through Ventilation

Fig. 2 shows a modified type of draw-through ventilation that may be used in cases where volatile solvents are being processed in tanks with many openings, and a standard draw-through ventilation may result in the formation of an explosive mixture. This type of control is also effective for processes performed at high temperatures.

The modified system consists of the installation of a false cover over the existing tank cover and the connection of an exhaust duct directly to the false cover. In general, the openings on the false cover coincide with those on the tank cover. Only the vapor escaping through the actual cover openings is exhausted. Minimum control velocities of 100 fpm should be maintained through the openings.

Slot Hood Ventilation

Figs. 3 and 4 show how slot hood ventilation is applied. The slot hood should be equipped with a flange as shown in the sketches. The flanged hood is approximately 25 percent more effective than an unflanged slot. The air volume required for control may be determined from formulas and tables found in the standard references.

A rule of thumb method for calculating the control air volume requirement in cfm is to multiply the area to be controlled by 150. To utilize slot ventilation, the kettle cover must be tight so that all evolution of gas, vapor and mist is through the tank opening or manhole. The slot should be located as close as possible to the kettle opening and should be designed to encompass as much of the opening as is practical. The use of slots on both sides of an opening is desirable for openings more than 24 in. wide.

The use of baffles as shown in Fig. 3 will reduce interference of drafts and cross currents and will increase efficiency.

The slot hood requires relatively large air volumes

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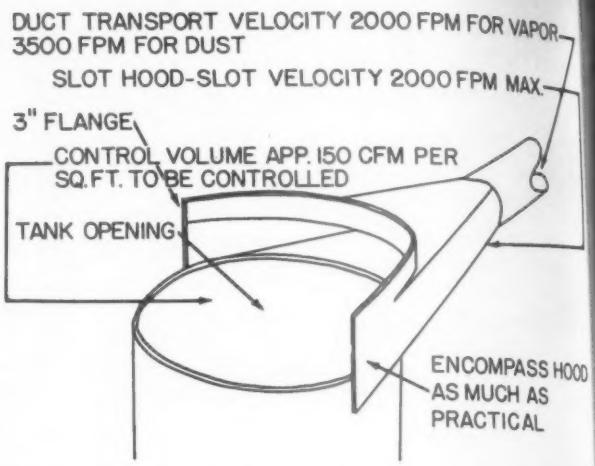

Fig. 4: *Slot for circular opening. Flanged hood is about 25 percent more effective than an unflanged slot.*

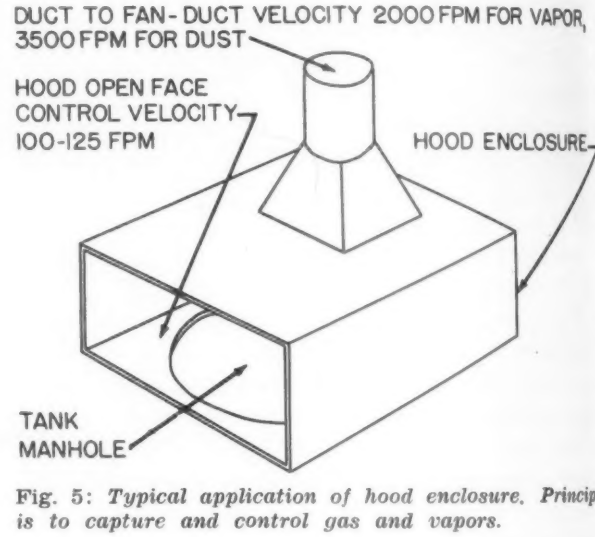

Fig. 5: *Typical application of hood enclosure. Principle is to capture and control gas and vapors.*

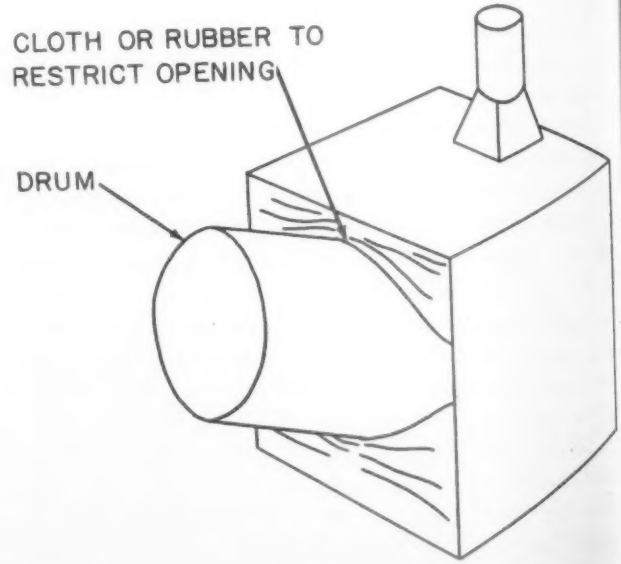

Fig. 6: *Hood enclosure, showing drum dumping.*

Accurate blower selection is easy with . . .

Fan Laws Made Easy

by C. O. Wood
Sturtevant Division
Westinghouse Electric Corporation

How to match air handling system with the fan requires an understanding of basic fan laws. This article tells how to select the right fan for the right job, and gives you an engineering background in the handling of air.

THE SATISFACTORY OPERATION of an air handling system requires that the fan and system be properly matched. Both the fan and the system obey certain basic laws which the application engineer should understand before attempting a fan selection. These fundamentals are described below in a manner which it is hoped will permit a better understanding of the fan and system relationship.

Assuming a certain duct system is, for the moment, in balanced operation with dampers fixed and air densities in the various parts of the system held constant, resistance of the system to the flow of air will be determined by amount of air flowing.

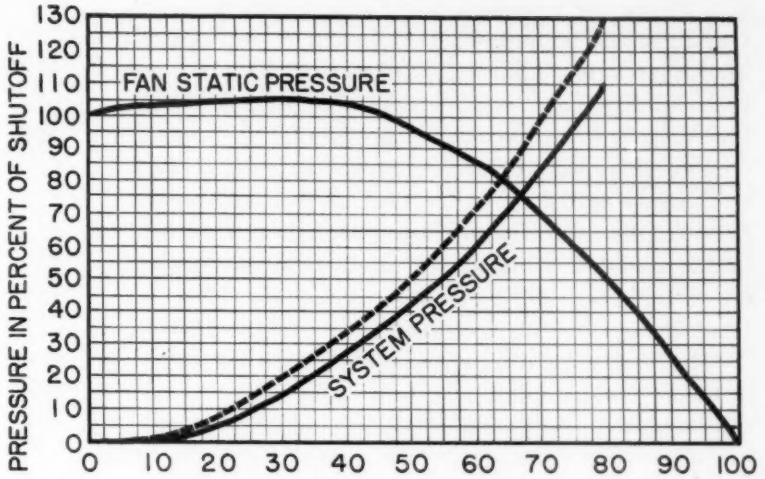

Fig. 1: *Graph shows that system resistance is proportional to the square of the volume of air flowing through the system. Note that when dampers are changed to new position, a different system is formed, as shown by dotted line.*

In the common system, which is typical of air conditioning, ventilating, or exhaust systems, the resistance (or pressure loss) of the system is proportional to the square of the volume of air flowing. (At Reynolds Numbers below about 2000 the resistance is proportional to the cfm – not to the square. But this application is rare.)

Fig. 1 shows this relationship in graphical form. When the dampers controlling the flow of air are changed to a new position, a different system is formed such as shown by the dotted line. The new system has the same characteristic of pressure loss proportional to the square of the volume, but the curve has been displaced to a new position due to change in damper resistance. It is necessary to know only one point, and the full curve can be calculated by the relation

$$\frac{P_1}{P_2} = \frac{(CFM_1)^2}{(CFM_2)^2}$$

The original system curve describes performance only as long as the system resistance is not altered by changing dampers, coils or filters plugging with dirt, changes in air density, or any change which affects the resistance at a given air flow.

With the system curve established there remains to determine whether a particular fan will supply the desired quantity of air. For this purpose the characteristic curve of the fan is laid over the system curve and the point of intersection is determined as in Fig. 1.

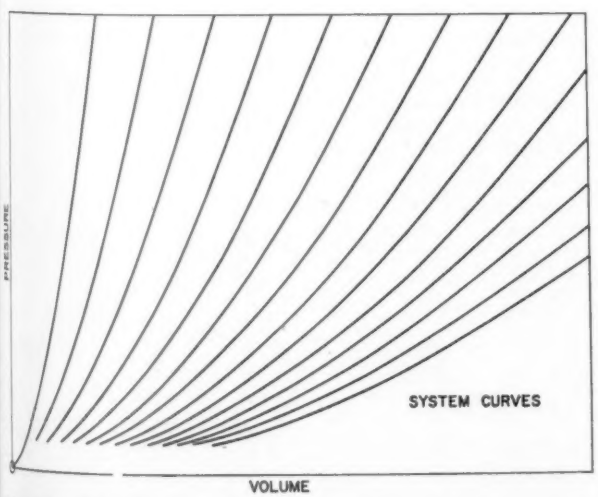

Fig. 1A: *This graph can be used on any fan curve to visualize where fan and system curves intersect. Curves should be redrawn on transparent paper.*

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(Fig. 1A can be used on any fan curve to see at a glance the intersection of fan and system curves. Curves should be redrawn on transparent graph paper. Merely spot one system point on the fan curve and then follow along parallel with the nearest system line until the fan curve is intersected.)

The important point to remember is that a fan will always operate at some point on its characteristic curve. This fact is sometimes clouded in an actual installation due to inaccurate pressure measurements or to the presence of an inlet spin (see "Tips on Duct Design" in AIR ENGINEERING, November, 1959).

The fan curve data are obtained from fan manufacturers usually in tabular form from which curves can be plotted, if desired. The manufacturers compile the data from laboratory tests using ductwork arranged so that the performance can be accurately determined.

There is a definite range on the fan curve where the system curve should intersect to obtain acceptable performance. This range is from peak pressure out toward wide open condition, as shown in Fig. 3. This range coincides with the maximum efficiency but there are also other reasons for limiting the operating range. In the area between blocked tight and peak pressure, fans tend to be unstable. That is, the air flow through the fan is unsteady and far from ideal, giving rise to pressure fluctuations and noise. This condition also exists near wide open, but to a lesser extent.

With fans having a deep dip in their pressure curve to the left of peak pressure, there may be a danger of intersecting the system curve in this undesirable area as shown in Fig. 4. In this case, the point of operation with the system could be at two or more places. This situation is highly undesirable and should be avoided either by use of a different fan or by a system with lower resistance.

A similar undesirable condition may be produced when two separate fans are operated in parallel on the same system. Parallel fans are here considered as fans operated with separate drives so they could be operated independently.

Assume we have a fan and system combination with characteristics as shown on Fig. 5. One fan is already operating at point **a.** as determined by the system and fan curve intercept. The second fan is now started and produces additional air flow as the outlet dampers are opened. The additional volume produced by the second fan is indicated by the horizontal distance between fan (1) curve and the system curve. These abscissae are replotted as a second system curve starting at **A.** If this system curve intersects the fan curve in the undesirable area, trouble will be encountered.

Fig. 5: *Graph shows what happens when fans operate in parallel.*

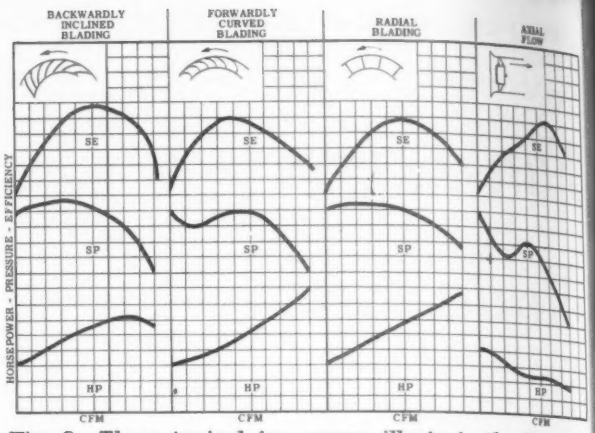
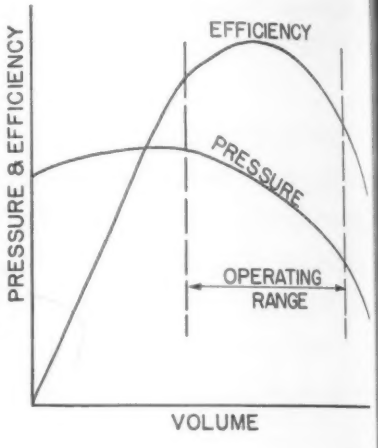


Fig. 2: *These typical fan curves illustrate the difference between various types of fans.*

Fig. 3: *There is a range on fan curve where system curve should intersect to obtain acceptable performance, as shown in this drawing.*



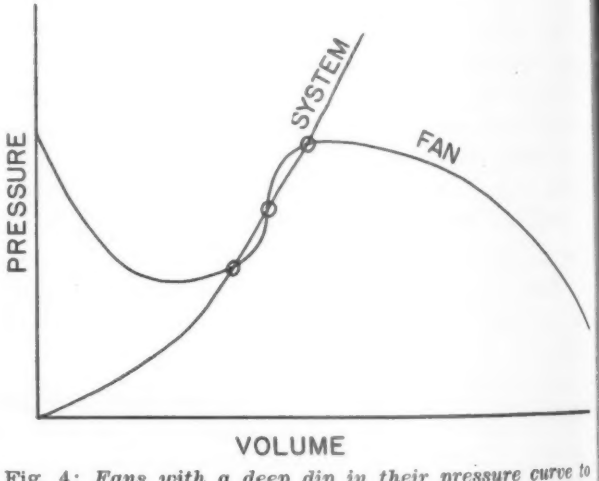
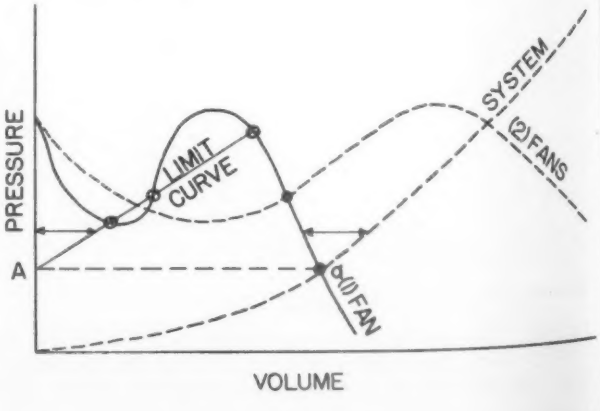


Fig. 4: *Fans with a deep dip in their pressure curve to left of peak pressure may intersect system curve in an undesirable area, as shown above.*



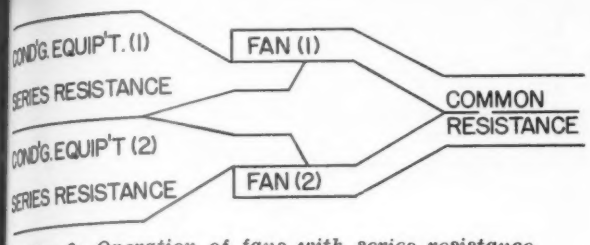


Fig. 6: *Operation of fans with serics resistance.*

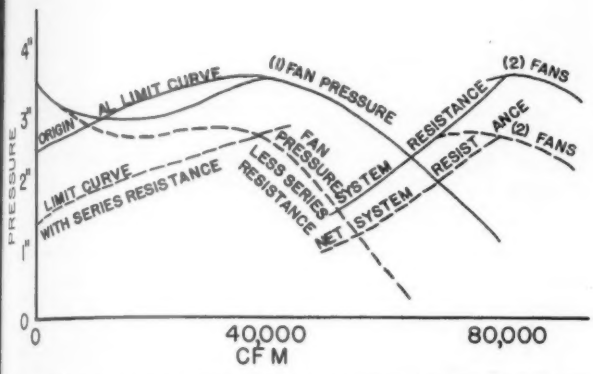


Fig. 7: *Chart shows how to calculate new fan performance curve when system resistance in series is added. New curve is calculated by deducting the series resistance from the original fan curve at each volume flow.*

The same precautions apply to intersection of the second system (which we will call a limit curve) with the fan curve as applied to a single fan and system. The limit curve should intersect the basic fan curve at only one point and this should be to the right of peak pressure.

The addition of resistance in series with each fan will often insure balance parallel operation. The additional resistance can be a short length of duct, heat transfer coils or similar equipment as shown in Fig. 6. The resistance associated with each individual fan is then considered as part of the fan package.

The new fan performance curve is calculated by deducting the series resistance from the original fan curve at each volume flow (P varies as CFM^2). Similarly the resistance must be deducted from the total system resistance giving a new system curve. Fig. 7 illustrates this procedure. The new combination thus produces a limit curve which intersects the fan package curve at a good angle and to the right of peak pressure.

A system and fan arrangement are normally designed using a specific air density. Most data on duct resistance and fan performance are given at standard air density of .075 pounds per cubic foot. If there are deviations from this density they must be allowed for in the design. The air density will of course be affected by altitude, temperature, pressure and humidity. Differences in density in various parts of the system can be sizeable and the losses should be figured using the applicable air density.

The density of air entering a fan inlet has a direct effect on its performance. The density is the one property that includes the effect of altitude, temperature, pressure and humidity. The fan laws state the relation of fan performance to density:

$$\frac{TP_1}{TP_2} = \frac{SP_1}{SP_2} = \frac{VP_1}{VP_2} = \frac{d_1}{d_2}$$

$$\frac{HP_1}{HP_2} = \frac{d_1}{d_2}$$

(Please turn to following page)

Unity Basis = Standard Air Density of .075 lbs. per cu. ft.*

***At Sea Level (29.92" Barometric Pressure) this is equivalent to Dry Air at 70° F.**

Air Temperature	Altitude in Feet Above Sea Level												
	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	15000	20000
	Barometric Pressure in Inches												
	29.92	28.86	27.82	26.81	25.84	24.89	23.98	23.09	22.22	21.38	20.58	16.88	13.75
70°	1.000	.964	.930	.896	.864	.832	.801	.772	.743	.714	.688	.564	.460
100°	.946	.912	.880	.848	.818	.787	.758	.730	.703	.676	.651	.534	.435
150°	.869	.838	.808	.770	.751	.723	.696	.671	.646	.620	.598	.490	.400
200°	.803	.774	.747	.720	.694	.668	.643	.620	.596	.573	.552	.453	.369
250°	.747	.720	.694	.669	.645	.622	.598	.576	.555	.533	.514	.421	.344
300°	.697	.672	.648	.624	.604	.580	.558	.538	.518	.498	.480	.393	.321
350°	.654	.631	.608	.586	.565	.544	.524	.505	.486	.467	.450	.369	.301
400°	.616	.594	.573	.552	.532	.513	.493	.476	.458	.440	.424	.347	.283
450°	.582	.561	.542	.522	.503	.484	.466	.449	.433	.416	.401	.328	.268
500°	.552	.532	.513	.495	.477	.459	.442	.426	.410	.394	.380	.311	.254
550°	.525	.506	.488	.470	.454	.437	.421	.405	.390	.375	.361	.296	.242
600°	.500	.482	.465	.448	.432	.416	.400	.386	.372	.352	.344	.282	.230
650°	.477	.460	.444	.427	.412	.397	.382	.368	.354	.341	.328	.269	.219
700°	.457	.441	.425	.410	.395	.380	.366	.353	.340	.326	.315	.258	.210

Fig. 8: *This table shows relationship of air temperature, altitude and barometric pressure to standard air density. Density directly proportional to Barometric Pressure established by the U. S. Standard Atmosphere-Altitude-Pressure relation. (Bureau of Standards Publication No. 82.) Density inversely proportional to absolute temperature.*

(Continued from preceding page)

CFM is not affected by density. Here we are referring to the effect on the fan performance curve. Density change at the fan inlet produces a new performance curve so that the intersection with the system curve may result in a different cfm through the system. This is illustrated in Fig. 9, where the fan curve has been displaced vertically downward due to a change in density. However, the system density has been held constant by temperature or humidity controls.

Both system friction losses and fan perssure vary directly with air density. Fig. 10 illustrates the change in fan performance and system resistance where the entire system density changes by the same percentage. The air density which determines fan performance curve is taken at the fan inlet. System losses are affected by the density in each particular part of the system.

It is possible in some cases that a change in density may occur in only a part of the system and the remainder of the system stays constant. The effect on the total system will of course depend on the relation of the resistance of the changed portion to the total. Fig. 11 shows the revised point of operation on the fan curve. Note that the change in point of operation is less than indicated by the change in system resistance. Once a system is in balanced operation, changes such as this are apt to be small since the usual practice is to avoid large changes in temperature by suitable controls. The difference between summer and winter operation, however, could be quite large unless the design makes proper allowance for it.

Previous paragraphs have described the change in flow of air due to damper changes in the system. Since this type of control may not be sufficient to provide a broad range of satisfactory performance, other types of control are often used. It should be noted that system dampering can produce a point of operation on the fan curve which is in the undesirable region and thus produce excessive noise and pressure fluctuations. System dampers are thus restricted to operation within the limits of acceptable fan performance as indicated in Fig. 12.

In order to produce a wider range of satisfactory performance and also to save on power, inlet vanes are often used. These are installed in the fan inlet in a manner such that they spin the air in the same direction as the fan rotation. This results in the fan doing less work and thus produces a new fan performance curve as shown in Fig. 13. With variable inlet vanes an infinite number of fan curves are available so that the operating point is always in an acceptable part of the curve. In addition, system dampers can be used for additional control. With the use of inlet vanes the power is also reduced along with the fan output. Where system dampers are used, the control is obtained by adding losses to the system. This can increase the power, or at best result in only a minor reduction depending on the shape of the power curve.

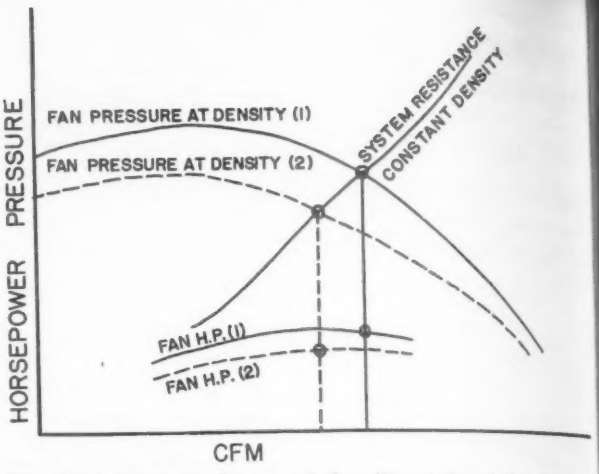


Fig. 9: *Effect of change of density at fan inlet (system density is constant).*

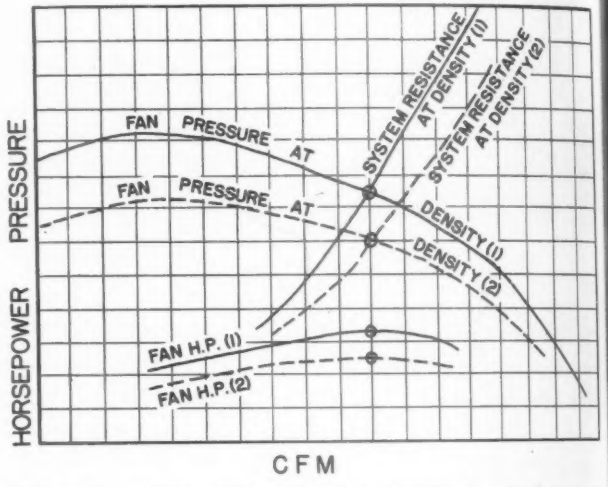


Fig. 10: *Chart illustrates the change in performance when entire system, including fan, changes density.*

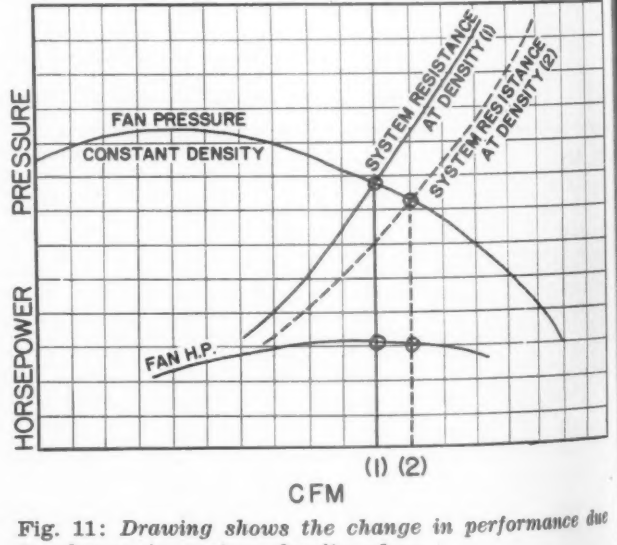


Fig. 11: *Drawing shows the change in performance due to change in system density alone.*

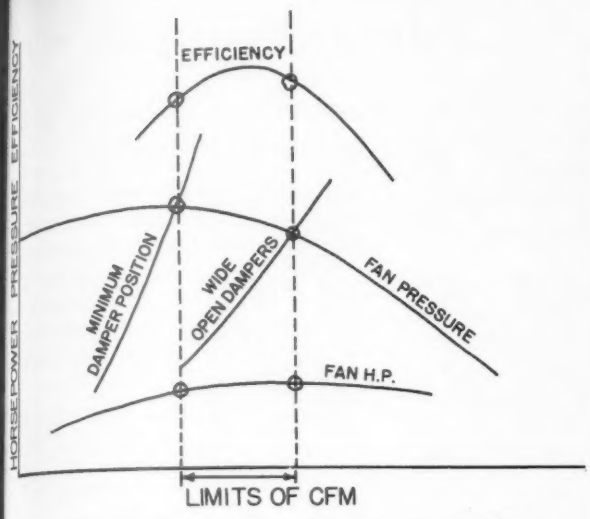


Fig. 12: *Effect of system dampers on air flow.*

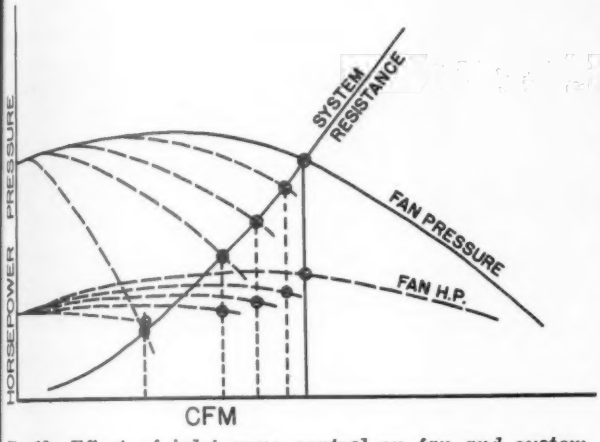


Fig. 13: *Effect of inlet vane control on fan and system performance.*

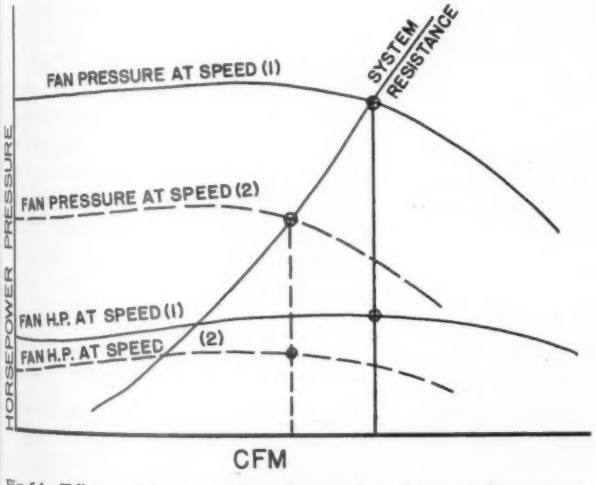


Fig. 14: *Effect of fan speed on fan and system performance.*

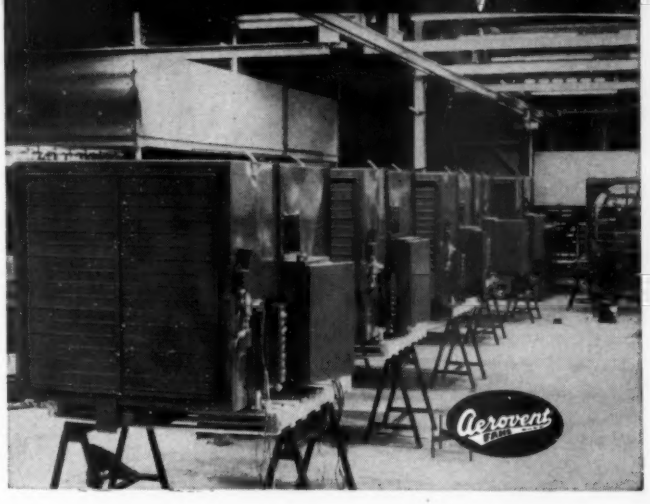
Fan outlet dampers are sometimes used for control but are generally not desirable for this purpose. They are placed at the fan discharge where the relatively high velocity and turbulent air strike them. This produces excessive noise and unduly hinders fan performance. For optimum performance, fans require

(Please turn to page 52)

increase production capacity . . .
improve fan and heating efficiency

with

gas-fired
air
make-up
units



Pictured above is a portion of the final assembly line at Aerovent showing 8 units slated for delivery to a large Midwestern automobile accessory manufacturing plant. Designed to supply ample quantities of clean, pre-heated or cool, outside air to replace air exhausted by ventilating systems, the Aerovent Gas-Fired Air Make-Up Unit keeps air fresh; eliminates drafts and negative pressures. Safe, dependable operation and automatic, semi-automatic or manual control with natural, mixed, manufactured or propane gas.

For winter or summer use, these compact, packaged units are available in four unit arrangements and four sizes from 36" to 54" for various capacities, BTU ratings and pressure conditions.

Write for bulletin 880.

OTHER UNITS AVAILABLE FOR STEAM OR HOT WATER

Air deliveries of all Aerovent equipment are tested and rated in accordance with established and accepted codes and each unit is guaranteed by the manufacturer to deliver its rated performance.

CERTIFIED PERFORMANCE

Aerovent
FAN COMPANY, INC.
Ash and Brian Streets Piqua, Ohio

New Literature

Three Airtemp Catalogs

Three new catalogs have been prepared for the Applied Machinery and Systems Department of Chrysler Corp.'s Airtemp Div.

Form ME-121 is a 20-page, two-color catalog which deals with accessible hermetic liquid chillers, 7.5 to 45 ton capacities.

Form ME-123 is another 20-page two-color data book which contains information on Chrysler's "W" Series packaged liquid chillers, 15 to 125 horsepower.

An eight-page, two-color folder, the AM&S Sweets Reprint Folder, covers the entire line of Chrysler's Applied Machinery and Systems Department.

Source: *Chrysler Airtemp, Advertising Distribution Center, Dept. AE, P. O. Box 1037, Dayton 1, Ohio.*

Incinerator Standards

Incinerator Institute of America has revised its incinerator standards as of April, 1960. Standards define incinerator terminology, analyze waste, classify incinerators, and state specifications of incinerators by classes.

Tables show broad classification of wastes to be incinerated and maximum burning rate of various types of wastes.

Price: $1.

Source: *Incinerator Institute of America, Dept. AE, 420 Lexington Ave., New York City 17.*

Engineers Manual, Vol. III

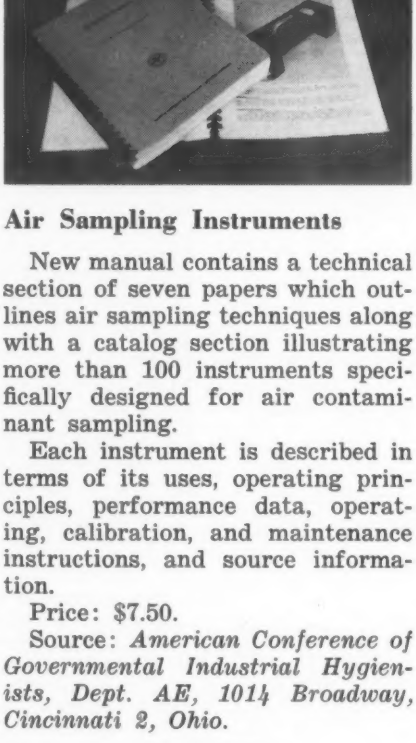
Volume III of Carrier's new Engineers Manual—a practical reference on air conditioning and refrigeration—is entitled System Design. It is designed to bridge the gap between air conditioning texts and manufacturer's catalogs.

Included in its 350 pages are 450 illustrations, charts and tables. Additional sections are planned so that Volume III will eventually consist of 12 parts covering some 750 pages. Each part will be easily identified by a different color for ready reference.

The just-released basic engineering section of Volume III contains three parts: (1) Load Estimating, (2) Air Distribution, and (3) Piping Design. Subsequent sections will be devoted to complete information on equipment and system engineering.

The first three parts of Volume III are now being distributed to Carrier field offices throughout the United States and Canada for release to consulting engineers. Copies also will be available for use by engineering schools and other agencies.

Source: *Carrier Corp., Dept. AE, Syracuse 1, N. Y.*



Air Sampling Instruments

New manual contains a technical section of seven papers which outlines air sampling techniques along with a catalog section illustrating more than 100 instruments specifically designed for air contaminant sampling.

Each instrument is described in terms of its uses, operating principles, performance data, operating, calibration, and maintenance instructions, and source information.

Price: $7.50.

Source: *American Conference of Governmental Industrial Hygienists, Dept. AE, 1014 Broadway, Cincinnati 2, Ohio.*

Water Cooling Coil Catalog

McQuay catalog #406 introduces a new direct selection method for all types of water cooling coils, and a complete, accurate compilation of data for quick, easy selection to meet any required specifications. Various types of McQuay water cooling coils are described and explained in detail with complete circuiting illustrations and application recommendations.

Psychrometric charts and curves are included.

Source: *McQuay, Inc., Dept. AE, 1600 Broadway St., N.E., Minneapolis 13, Minn.*

Brochure on Bradley

William R. Bradley and Associates, a new firm in the air engineering consulting field, has issued a brochure describing the services offered and the background of Bradley, who is past president of the American Industrial Hygiene Association.

Source: *William R. Bradley and Associates, Dept. AE, 18 Green St., Newark 2, N. J.*

Industrial Louver Bulletin

Bowman Bulletin IL-1 features industrial louvers of fixed and operating types. Curved return blade design is stressed. Included are details on construction, sizes, materials, gauges, screens, and specifications.

Source: *Bowman Steel Corp., Dept. AE, Box 2129, Pittsburgh 30.*

Primer On "Selection And Use Of Pneumatic Conveyors"

A concise eight-page report on "Selection and Use of Pneumatic Conveyors," has been written by Howard S. Sayre, manager of General Conveying Div., Fuller Co. Special sections discuss what the three basic systems are, basic elements of each system, various component parts, types of conveying lines, valves, indicators, and controls.

Source: *Fuller Fact File ER-G-9, Fuller Co., Dept. AE, Catasauqua, Pa.*

AiResearch Components Catalog

More than 2,500 components for control of gas or liquid over a temperature range of -320F to 1500F and pressures to over 3500 psig are covered in a new catalog.

Major items available for process industry, aircraft, or missile applications include fuel control systems, pneumatic and electrical valves, actuators, air motors, and thermostats.

Source: *AiResearch Mfg. Co., Dept. AE, 402 S. 36th St., Phoenix, Ariz.*

New Appointments

R. S. Fries has been named manager of commercial operations, a new post for Minneapolis-Honeywell Regulator Co. He assumes overall responsibility for the Minneapolis Panel Div. and for factories in Chicago and Wabash, Ind.

Fries

Fries was formerly manager of Honeywell's Appliance Controls Div. in Los Angeles.

James P. Kneubuhl has been elected president of Research-Cottrell, Inc. He succeeds **William Hinkley,** who will continue as chairman of the board and as president of the parent organization, Research Corp., a foundation.

Kneubuhl

Kneubuhl comes to Research-Cottrell from the Fluor Corp., Ltd., Los Angeles, where he was vice president in charge of utility and government sales.

H. W. Rainey has been named marketing manager of the Westinghouse Sturtevant Div. Formerly general sales manager, he will have responsibility of all phases of marketing activity including field sales and marketing services.

Rainey

Appointment of **Charles W. Lockhart** as vice president, sales has been announced by Buffalo Forge Co.

Lockhart

Lockhart joined the company's engineering department in 1936, was manager of the firm's San Francisco sales district from 1945 until 1953 and, most recently has served as sales manager of the Air Handling Div.

Robert E. Liebendorfer has been appointed manager of manufacturing for Worthington Corp.'s Air Conditioning & Refrigeration Div.

Liebendorfer

Liebendorfer will make his headquarters at the division's general office in East Orange, N. J. He will have charge of all the division's manufacturing operations located in plants at East Orange; Holyoke, Mass.; and Decatur, Ala.

Liebendorfer has been associated with the Curtiss-Wright Corp. in Woodridge, N. J. since 1942.

Carl E. Cannon has been appointed product sales manager for electric heating at the Westinghouse Electric Corp.'s air conditioning division.

Cannon

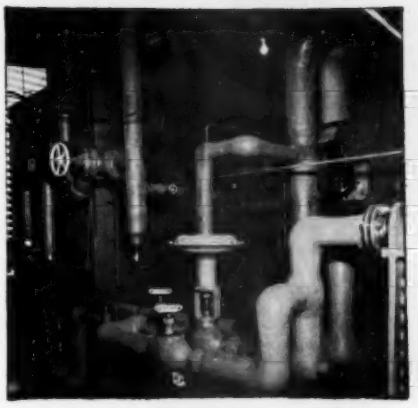
Cannon will be responsible for product planning, coordinating merchandising programs, and recommending pricing policies for the company's line of electric heating equipment.

Cannon first became associated with Westinghouse as sales training director for the company's air conditioning division in 1957. Last year he was appointed manager of sales promotion and training.

Joseph B. Elliott, formerly president of Schick, Inc., and Tele-Dynamics, Inc., and executive vice president for Radio Corp. of America, has been named as president and general manager of the York Div. of Borg-Warner Corp. effective June 1. He succeeds **Henry M. Haase** who has headed York since 1956 and is now being transferred to Borg-Warner headquarters in Chicago.

Elliott

DRY AIR...
PRECISELY AS YOU NEED IT



NIAGARA CONTROLLED HUMIDITY AIR CONDITIONING

removes atmospheric moisture by direct contact with an absorbent liquid in a compact spray chamber. The spray contact temperature and the concentration of the absorbent liquid, two factors that are easily controlled, determine precisely how much moisture remains in the air leaving the unit.

This Niagara Controlled Humidity method, using Niagara Hygrol Absorbent Liquid is....

The only really precise method of air conditioning because it removes moisture as a separate function from heating or cooling to give you assurance of accuracy of air moisture control.

It is the most reliable because the absorbent is continuously and automatically kept at the proper concentration. No moisture-sensitive instruments are required to control your conditions.

It is the most flexible because with it you can either hold the precise condition you need as long as you wish or vary it with accuracy.

It is easiest to operate and maintain because the equipment and controls are simple and trustworthy.

This method is successfully used in the storage, testing and production of hygroscopic materials, in process control and as a pre-dehumidifier in comfort air conditioning.

Write for Bulletins Nos. 122 and 140.

Address Dept. AIR-8

NIAGARA BLOWER COMPANY
405 Lexington Ave., New York 17, N. Y.
District Engineers
in Principal Cities of U. S. and Canada

New PRODUCTS

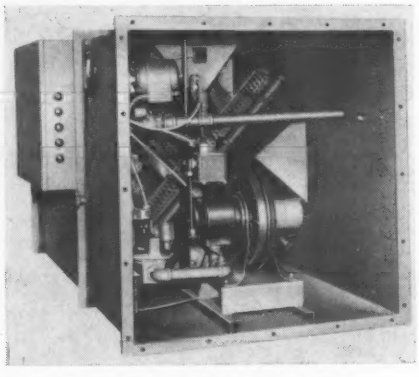
Waste Can-Type Dust Collector

Purpose: Traps machine-produced dust, shavings, chips at point of origin.

Features: Low cost portable dust collecting system, Model '50' fits any 20 or 24 gal. waste can. Portable, it can be moved from machine to machine. Operation is of the cyclone separator type so that heavy particles are precipitated before reaching self-cleaning radial fan. After-filter bag removes fines.

Price: $149.50 f.o.b. Cincinnati, not including waste can.

Source: Cincinnati Fan & Ventilator Co., Dept. AE, 3548 Montgomery Road, Cincinnati 7, Ohio.



Gas-Fired Intake Air Units

Purpose: Supply make-up air to replace that removed by exhaust systems.

Features: Four basic units range from 15,000 to 90,000 cfm, 1,000,000 to 7,000,000 Btuh. Basic units include burner, controls, and belt or direct driven fan in single housing.

Source: Hartzell Propeller Fan Co., Dept. AE, Piqua, Ohio.

Large Horsepower Magnetic Adjustable Speed Drives

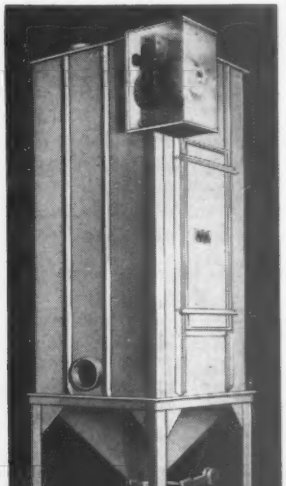
Purpose: Provide versatile adjustable speed performance over an automatically regulated 20:1 range. For use in pumps, blowers.

Features: Based on a liquid cooled magnetic coupling design. Ratings from 75 to 4,000 hp. Bearings can be relubricated without disassembly. Cooling system design eliminates bearing condensation and drive flooding, permits planned flow of air through drive at all times.

Drive package includes drive unit with water controls, controller enclosure, and operator's station, it is pointed out.

Source: Louis Allis Co., Dept. P-AE, 427 E. Stewart St., Milwaukee 1, Wis.

RUEMELIN *Dust Control* EQUIPMENT



Vacuum Type Dust Filter with Electric Bag Shaker.

Ruemelin Dust Filters achieve a high rate of efficiency in the control of fine dusts. Our tubular bag design provides —

- Low resistance to air flow.
- Thorough shaking of bags while fan is shut down. Eliminates tautness.
- Maintenance, inspection and replacement of tubes made easy by our patented design.

Ruemelin Dust Filters collect and suppress dust created from all types of industrial applications. Available in single compartment or continuous multi-compartment units in capacities from 500 to 30,000 CFM.

Over 3000 collectors in service. Write for bulletin 24-D.

RUEMELIN MFG. CO.

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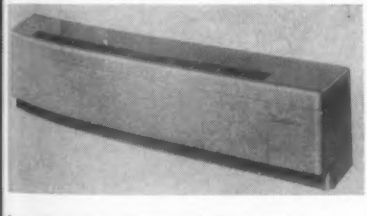
Invisible Fly Wall

Purpose: Downward moving current of air over doorways repels insects and permits commercial establishments to keep their doors open.

Features: Super Vac Invisible Fly Wall mounts above entrances and is furnished for standard door widths with special widths available on order. Propeller is perfect spiral air screw used by fire departments for evacuating smoke. Air is sucked over blade surface, discharged over motor, keeping unit running cool.

Source: Super Vacuum Mfg. Co., Dept. AE, 319½ E. 17th Ave., Denver, Colo.



Low Height Fan Coil Unit

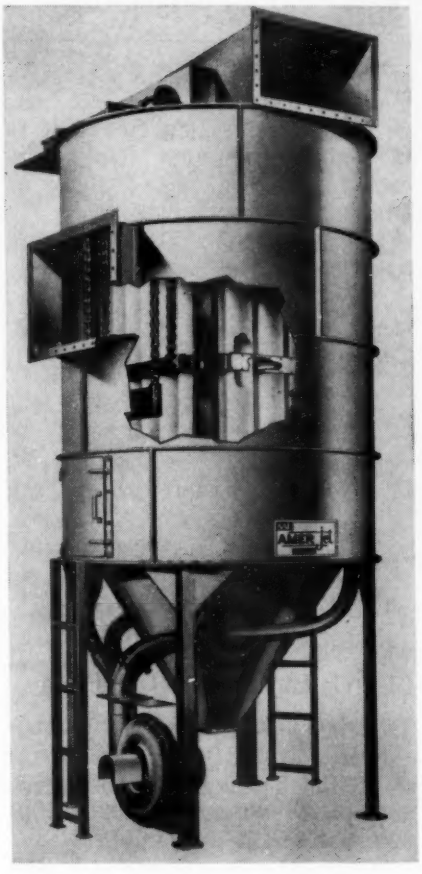
Purpose: Permits use of fan coil unit in buildings featuring floor fenestration or low windows.

Features: Low height; only 14½ in. high. Utilizes two small diameter pipes and a condensate drain. Installed free standing it provides clearance for drapes. Multispeed motor control regulates volume of air delivery and noise levels.

Equipped with permanent, split-capacitor motors for low power consumption. Four standard units range in length from 44 to 96 in., weight from 130 to 240 lbs., velocity from 200 to 600 cfm, and Btuh from 14,300 to 44,900.

Source: Modine Mfg. Co., Dept. AE, 1500 DeKoven Ave., Racine, Wis.

Reverse Jet Fabric Dust Collector



Purpose: For any applications requiring reclaiming of dry materials such as cement plants, foundries, mineral grinding systems, and all types of chemical processes.

Features: Model B AMERjet reverse jet fabric dust collector can be shipped in small sections and assembled at installation site. By using reverse jet cleaning principle, a nearly constant pressure drop can be maintained across the AMERjet. Positive air cushion removes entrained dust from filter fabric.

Source: American Air Filter Co., Inc., Dept. AE-PD, 215 Central Ave., Louisville 8, Ky.

(Please turn to following page)

Use Communications Center, page 37, for requesting more information about articles, advertised products, literature, new products, new items, etc.

If you wish to contact manufacturers directly, street addresses are given. But please mention you saw it in AIR ENGINEERING.

in laying out your client's plant

ARE YOU GUARDING AGAINST DUST DAMAGE TO MACHINES?

Will there be dust-producing machines in your client's new plant? Such as metalworking, wood-working or penumatic conveying equipment? If so, you should plan now for dust control.

Because dust clogs and gums up costly machinery, lowers production efficiency, causes breakdowns and higher maintenance costs. In addition, dust is harmful to the health of employees.

More and more professional men, laying out new plants and remodeling older ones, are specifying Torit Dust Collectors. Torit Dust Collectors have proved 98% efficient in removing dust. They are compact, easy to install and maintain, and cost far less than many types of dust collecting equipment.

Contact a Torit representative. He will give you dust collector specifications, performance charts, dimensional drawings, installation suggestions . . . all the information you need.

Write:

TORIT

MANUFACTURING COMPANY

1133 Rankin St., St. Paul 16, Minn., Dept. 1927

Cyclone model. *Also available in portable cabinet models.*

New PRODUCTS

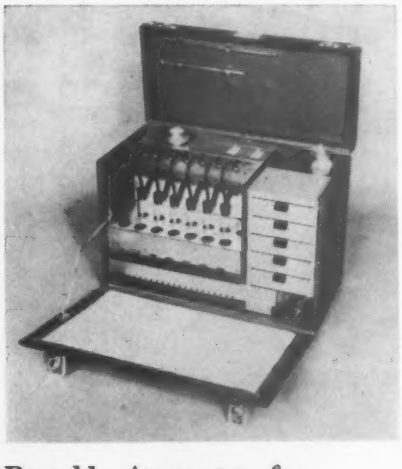
(Continued from preceding page)

Portable Dust Suppressor

Purpose: For single point dust suppression or controlled wetting of raw materials.

Features: Chem-Jet portable dust suppressor is made in four models. Each system includes proportioner, mixing chamber, and auxiliary controls mounted on hand truck. Proportioner can be factory adjusted to dispense from one to 11 gpm of non-toxic dust suppression solution.

Source: Johnson-March Corp., Dept. AE, 1724 Chestnut St., Philadelphia 3.



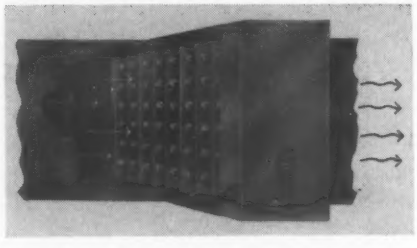
Portable Apparatus for Testing Air Pollution

Purpose: Use in emergency or preliminary field work for determining gaseous or particulate pollutants in the atmosphere.

Features: Employs a colorimeter to estimate amounts of eight gaseous pollutants and can also be used to indicate presence of 10 particulate pollutants. Can be operated by persons with little or no training in chemistry.

No. 20770 air pollution field test kit is priced at $595.

Source: Central Scientific Co., Dept. AE, 1700 Irving Park Road, Chicago 13.



Electric Blast Coil Space Heaters

Purpose: For duct installation.

Features: UL listed. Easily installed in the duct work. Requires no floor or wall space or flue. Slip-in construction available.

Stock sizes from 1,000 to 30,000 watts (3,400 to 102,000 Btuh). Custom sizes from 500 to 1,000,000 watts (1,700 to 3,412,000 Btuh).

Source: Industrial Engineering & Equipment Co., Dept. AE, 24 Hanley Industrial Court, St. Louis (Brentwood) 17, Mo.

Beryllium Dust Monitor

Purpose: For monitoring airborne beryllium dust. Takes samples of air and presents them to a recording ultra-violet emission spectrometer capable of analyzing a liquid solution.

Features: Can handle six 100-liter air samples per hour. Monitor will function automatically and continuously for 10 hour periods without attention. Audible and visible alarms operate if beryllium concentration exceeds pre-set level.

Source: Glass Developments Ltd., Dept. AE, Sudbourne Road, Brixton Hill, London, S.W. 2, England.

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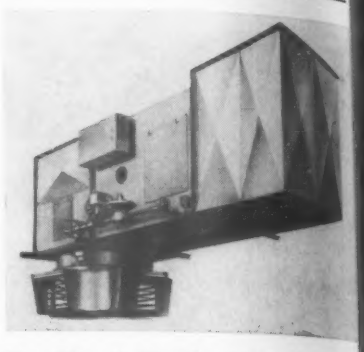
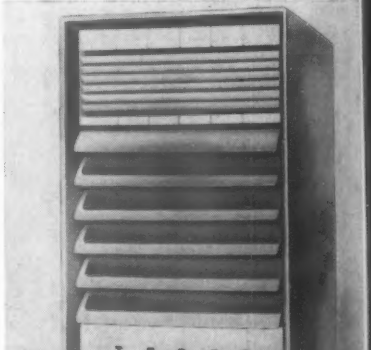


Gas-Fired Fresh Air Supply Heaters

Purpose: Provide warmed air to replace loss through exhaust systems.

Features: Have high turndown ratios which permit minimum temperature rise as low as 3.3F. Available in five sizes from 15,000 to 50,000 cfm and 1.5 to 4.5 million Btuh based on any clean gaseous fuel with a range of 800 to 3200 Btu/cu. ft. Wide choice of discharge arrangements available including Wing revolving discharge for even air distribution.

Source: L. J. Wing Mfg. Co., Dept. AE, Linden, N. J.

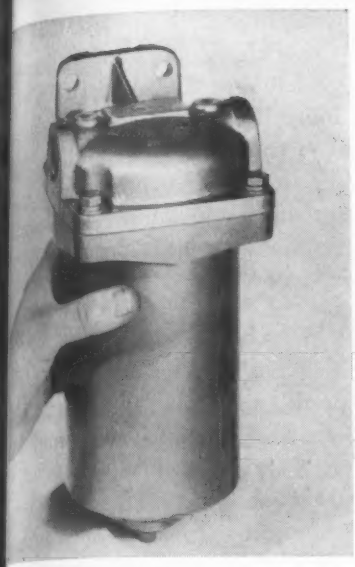


Gas Fired Unit Heaters

Purpose: Furnish heat in commercial stores, factories, and warehouses.

Features: Propeller and blower heater units come in 10 sizes from 30,000 to 250,000 Btu input capacities; duct heaters in six sizes from 60,000 to 250,000 Btu input. Units come equipped with two highly sensitive limit controls which give lower operating cost and avoid drafts on start-up.

Source: The Trane Co., Dept. AE, La Crosse, Wis.

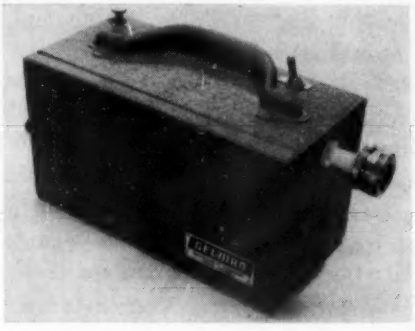


General Purpose Filter Assembly

Purpose: Filtration of most fuels, lubrication oils, air, and other gases and liquids; for environmental air systems for electronic equipment.

Features: Series 3100 has pore size ratings from two to 100 microns and is available with five different element materials: woven wire cloth, sintered bronze, pleated resin-impregnated cellulose sheet, stacked resin-impregnated cellulose washers, and helically wound resin-impregnated cellulose filter ribbons.

Source: Bendix Filter Div., Bendix Aviation Corp., Dept. AE, 434 W. 12 Mile Road, Madison Heights, Mich.



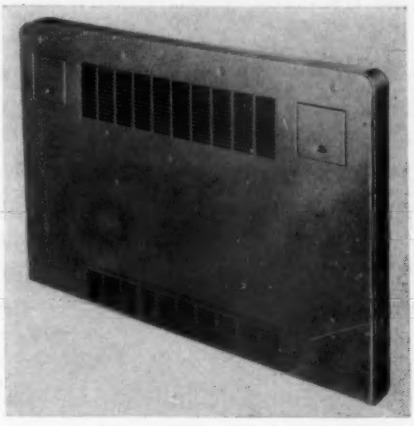
Light Weight Air Sampler

Purpose: For hard usage in survey work where it will be used regularly for an eight hour working day.

Features: Bantam Sampler weighs only 9 lbs. and samples air at rate of 2 cfm. Centrifugal carbon vane pump unit needs no lubrication.

Flow meter is directly calibrated in liters/minute. For an emergency sampling job it can be slipped into a suitcase and taken on a plane. Price: $130.

Source: Gelman Instrument Co., Dept. AE, Chelsea, Mich.



Heating-Cooling Unit

Purpose: For maximum space saving in air conditioned areas.

Features: CRVR model has finished front for total recess and spacers for semi-recessed mounting. Available in four sizes at a variety of cooling and heating capacities with water or direct expansion coils. Has individual room control, filter.

Source: Dunham - Bush, Inc., Dept. AE, West Hartford, Conn.

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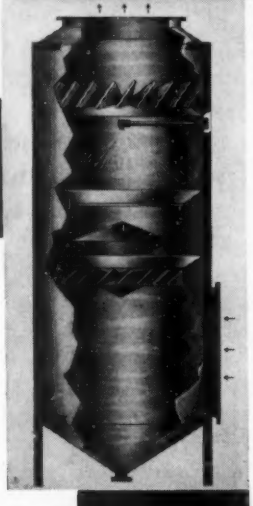

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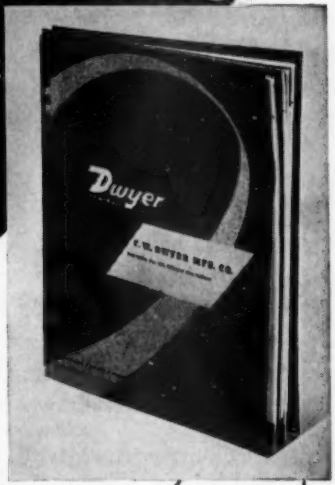

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Make-Up Air

(Continued from page 29)

air to pass thru the coil and part of the air to by-pass the coil. These two streams of air would mix in the fans and enter the space at the mixed air temperature desired. Under this ideal situation there would be no control valve required in the steam supply line to modulate the steam pressure and there would be full steam pressure in the coil at all times.

The trouble with such an ideal picture is that most face and by-pass dampers leak and eddy currents of the air stream pass in and out of the coil, while other currents wipe the hot surface of the face damper to the extent that a temperature rise of from 10F to as high as 45F is possible thru the unit with the face damper tightly closed. The higher the steam pressure or steam temperature, usually the higher the temperature rise under such conditions. In order to control these conditions an automatic valve or valves are then required in the steam supply to the coil in addition to the control of the face and by-pass damper.

If a two position (open or closed) valve is installed in the steam supply, trouble might occur for we are controlling the coil air discharge temperature. Room temperature control alone might work with this type of valve but fan discharge control would cause the valve to cycle open and closed under certain outdoor temperature conditions. This cycling would occur because, if the valve was closed and no steam was in the coil, there would be no temperature rise to the air, but if the valve was open and the coil was full of steam there would be a 10F or, possibly, more temperature rise. At certain outdoor temperatures our discharge thermostat would be calling for a temperature in between the two temperatures resulting from the above conditions, and thus cause the valve to cycle open and closed in rapid succession.

A usually acceptable low limit or fan discharge control can be obtained by a modulating reversing series control in the following sequence: After the face damper has completely closed, a modulating steam valve in the steam supply to the coil will gradually close on a call for less heat and the steam valve will modulate to a wide open position on a call for more heat, before the face damper starts to modulate open, as shown in Fig. 12.

High Pressure Steam Coil Control

For accurate fan discharge air temperature control when high pressure steam is used, two valves are usually required in steam supply line. One valve is a two-position unit sized for full capacity of coil; second valve should be sized to modulate steam used because of leakage of air through the dampers, after face damper has closed. Modulating valve should be installed in a by-pass line around the two-position valve.

When the face damper has been modulated to its full closed position on a call for less heat, the larger two position valve closes and the small modulating by-pass valve modulates toward a closed position. On a call for more heat, small valve modulates to its open position before the two position valve opens and the face damper begins to open. With this control, exact fan discharge temperature control of a face and by-pass damper unit can be obtained throughout its entire capacity.

Direct Fired Units

There are other types of factory built units known as "direct fired" units that are often used for fresh air make-up work. These units employ a furnace section as the heating device which may be gas fired, oil fired, or even stoker fired. The usual type of temperature control applied to such units is equivalent to the face and by-pass temperature control of a steam coil. The fans either force the air through the furnace section, or through the by-pass, or a portion of the air through both to obtain a mixture, according to the demand of the controlling thermostat which actuates a damper motor on the mixing dampers.

The firing device is usually controlled by a thermostat located in the bonnet or hot air plenum, which controls firing device to maintain a fixed temperature at that point. An outdoor reset thermostat may be used to vary the bonnet temperature in accordance with the fresh air temperature.

"Modulating" type burners, rather than the "on-off" type for either gas or oil, are a necessity when units of this type are used as make-up air units with continuous fan operation, because the time lag in recycling an "on-off" burner is usually so great as to cause cold air to be blown from the unit when the burners are in the "off" cycle. Usually an auxiliary contact in the mixing damper motor is connected to shut off the firing device when the face damper modulates to its full closed position, in order to prevent overheating. This would probably only occur in mild weather.

Still another form of direct-fired heating device for make-up air that has been widely used in recent years has been the type of gas burner that burns the gas directly in the air stream.

A single burner with a modulating control is available that has a 16 or 20-to-1 turndown ratio.

(Please turn to page 52)

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If you wish to contact manufacturers directly, street addresses are given. But please mention you saw it in AIR ENGINEERING.

Beryllium

(Continued from page 33)

Unattended Equipment

In the category of unattended equipment are storage bins and tanks, automatic transfer gear, and automatic, continuous feed process devices. Since frequent access is not required, the equipment can normally remain sealed (or reasonably enclosed) so that contaminant escape can be virtually eliminated. This does not eliminate the requirement for ventilation. An absolute seal is infrequently attainable even on a simple storage bin.

Significant leaks can occur at gasketed manhole covers, material inlet pipes, and discharge pipes or hoppers, especially after repeated temporary removal for maintenance or access. These avenues of escape must be carefully watched for incipient deterioration or loosening of fittings. The minimum ventilation requirement for a fixed closed container is the application of negative pressure to prevent exfiltration from the inside portion free of bulk material, under all conditions of feed. To prevent loss of gross amounts of material, it is sometimes desirable to install a filtered vent.

Automatic transfer conveyors should be completely enclosed and should be ventilated at each point of transfer. The same applies to continuous feed devices. Rotary kilns, for instance, should have a ventilated collar around each end to contain the dust which may leak at the material transfer points, as shown in Fig. 7. A continuous feed centrifuge, although closed and processing wet material, also operates at a slight positive pressure on the housing and can emit significant concentrations of mist. Negative pressure on the casing and ventilated collars around packing glands will successfully contain the most dust, as shown in Fig. 6.

Transfer of Material

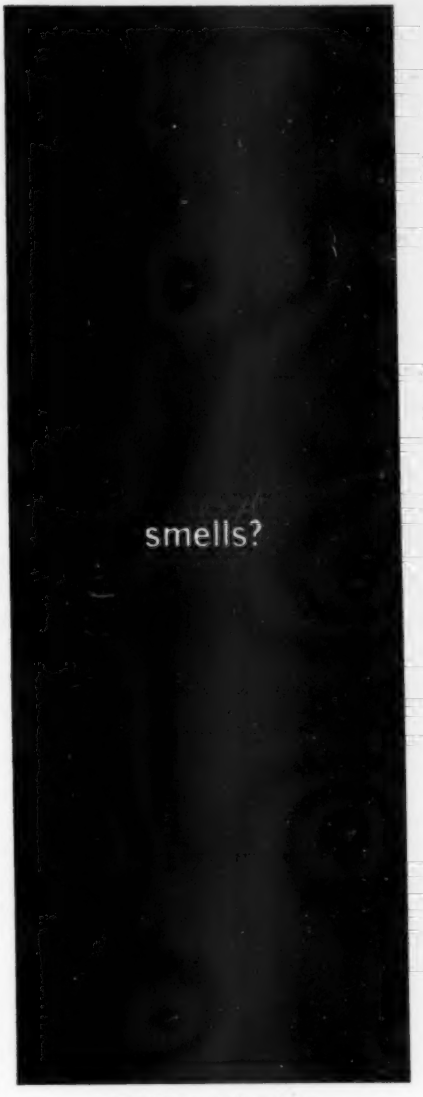
Material transfer is among the most difficult operations to control. Drum filling and dumping steps are consistently among the most dusty operations. Up until the present time no fully effective hood design for either operation has come to the attention of the authors. Repeatedly, designs which appeared foolproof at the conceptual stage have shown flaws when put into practice. On the other hand, many designs are reasonably good and can provide satisfactory control if the operator follows the prescribed procedures.

Automatic conveyors, where applicable, can eliminate the routine dust problem almost completely. This is especially true of the tubular and pneumatic types, although screws, belts, and buckets can be effective if suitable sealed and ventilated enclosures are installed. Maintenance on such equipment can, however, be quite dusty. If the material to be transferred is particularly abrasive or corrosive, so that frequent maintenance of conveying equipment is needed, the choice between manual and mechanical transfer should be carefully deliberated. Examples of both manual and automatic transfer operations and their relative utility are described below.

Where processes are conducted in chemical hoods, transfer to and from the hoods may be accomplished with relatively little hazard and no special auxiliary hooding provided that care is exercised. This applies to relatively small quantities of material which can be easily carried in small containers (e.g., up to one gallon cans).

The transfer concept is quite simple: a container capable of being tightly sealed is filled manually within the chemical hood and the cover applied and sealed. Before removal from the hood the exterior of the container must be thoroughly cleaned with a damp cloth or a vacuum cleaner, but the cleaning tools should remain within the hood. The container may then be removed without hazard. An obvious precaution is that the operator's hands and sleeves must not be contaminated when withdrawn from the hood. If this is otherwise inevitable, the operator should work through gloves attached to access ports, which may slide along the front of the hood from one operation to the next.

As long as the filling is done within the hood and the container can be adequately cleaned, dusting can be easily controlled. Container dumping should be similarly executed within the hood. When the containers are too large or heavy for convenient handling within the hood, the control progresses to a more elaborate but less positive technique. If a drum is to be filled outside the hood, specific drum ventilation is required. Such an arrangement may be considered in the same class as production drum filling stations. ▲▲



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Make-Up Air

(Continued from page 50)

In other words, a single burner with a total capacity to heat the air from 0F to 80F or 0F to 100F can be modulated down to approximately a 5F air temperature rise. We are thus able to modulate this type of burner in the same way that we control a single steam coil with one modulating valve. We are also able to overcome the shift in control point caused by droop, by the use of outdoor reset, with the control of this type of burner.

Types Of Controls

Available types of controls may be classified as electric, electronic and pneumatic. Practically all of the control systems or sequences that we have discussed may be accomplished by means of any one of these three types of control or combinations of same. One type of control might be able to accomplish a certain sequence in a more simple manner or more economically than another. It is also true that different types of controls would have to accomplish a particular control sequence in a slightly different manner, but the results could at the same time be substantially similar.

We have not taken up use of hot water as a heating medium for outside air make-up units, because in large industrial applications this medium is relatively less common.

If any of our readers wish data on hot water control methods for make-up air units, please so indicate on the handy card in the Communications Center on page 37. Ed. note. ▲▲

Chemical Industry

(Continued from page 36)

for control. If solids are charged directly into the vessel opening, excessive raw material dust loss may occur because of the proximity of the exhaust opening to the material charging point. If drums are charged through a hopper fitted into the manhole, the slot hood will not be effective.

Slot hood ventilation may be designed to include the kettle agitator packing gland. This design will be discussed in a future column.

Hood Enclosure

Figs. 5 and 6 show the typical application of hood enclosure. The manhole or tank opening is enclosed in a three-sided mechanically exhausted booth. The principal of the hood enclosure is to capture and control gas and vapors after they have escaped through the manhole or tank opening. Therefore, the tank cover should be tight. A control velocity of 100 - 125 fpm should be maintained across the open face of the hood to realize optimum control. This type of hood provides excellent control of dust liberated during charging of solids into the manhole as well as excellent control of gases and vapors.

Since the exhaust connection for the hood enclosure is located far away from the dumping point, dust losses are insignificant. The hood enclosure can be designed so that hoppers into which drums of material are dumped may be accommodated within the hood. The enclosure may be made large enough to allow a drum to be upended within it. The hood must, of course, be designed so that it does not interfere with process operations.

Dependent upon the operations performed, satisfactory control may be realized by hood enclosure using less exhaust ventilation than the other two methods. ▲▲

Fan Laws

(Continued from page 43)

a section of straight duct at the discharge to allow the full transformation of velocity to static pressure. Partially closed dampers at the discharge thus are a waste of power. Discharge dampers, when installed, are usually for shutoff purposes.

If used for control, discharge dampers produce both a higher system resistance and a lower fan performance curve.

Speed As A Control

Speed variation is an effective and often used method of controlling fan performance. The control of speed is accomplished in a number of ways including fluid drive, variable belt drive, two speed or variable speed motor, and turbine drive. The various methods have advantages which must be appraised against cost by the user.

A change in speed has an effect on the fan performance as defined by the fan laws:

$$\frac{CFM_1}{CFM_2} = \frac{RPM_1}{RPM_2}$$

$$\frac{TP_1}{TP_2} = \frac{SP_1}{SP_2} = \frac{VP_1}{VP_2} = \left[\frac{RPM_1}{RPM_2}\right]^2$$

$$\frac{HP_1}{HP_2} = \left[\frac{RPM_1}{RPM_2}\right]^3$$

Any change in fan speed thus produces a new performance curve which intersects the system curve at a different point as shown in Fig. 14. ▲▲

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Fume Short-Circuiting

(Continued from page 21)

opening, which if properly sized would not materially add to the system static loss. (If necessary, part of this duct could be hung over one end of the roof and partially down the side of the building.)

If the new entrance duct were located a sufficient distance from the present chimney location and were limited in height to maintain the aesthetic design, a simple and relatively low cost solution to both problems would be available. If this technique is not feasible for some reason, then other and much more costly measures would have to be entertained.

Use Of Filters

Smoke, soot, and other particulates could be collected on paper, fiber glass, fabric, or mineral fiber filters installed on the fresh air intake. These filters are available in fixed panels (such as on the standard home warm air furnace) which are replaced from time to time as required, or on rolls which are automatically rotated on a predetermined timed cycle to expose fresh filter media.

The cycle rate depends upon particulate loading and allowable pressure drop. Use could also be made of electrostatic filters which are more efficient but accordingly more costly.

Activated Charcoal Filters

The odor portion of the problem could be successfully corrected by the addition of an activated charcoal filter bed located on the downstream side of the dust removal equipment. This location lessens contamination and plugging of the dust collecting filter media.

The addition of odor masking agents in the air stream would be of questionable value as a solution to this particular type of problem.

Incineration, whether by direct flame or catalytic means would be much too costly to consider in this application.

The activated charcoal is marketed in cannisters, panels, or cells depending upon sizing and configuration requirements. One compensating factor which could help amortize the cost of the odor control equipment would be the ability to reduce fresh air make-up requirements with resulting savings in heating or cooling costs.

One "trick" method available which may be less costly than the control equipment cited above (if dual-fuel burners are already installed) would be to use gas when the wind blows from the "wrong direction." Firing could be automatically achieved by wind directional equipment and suitable relaying devices. ▲▲

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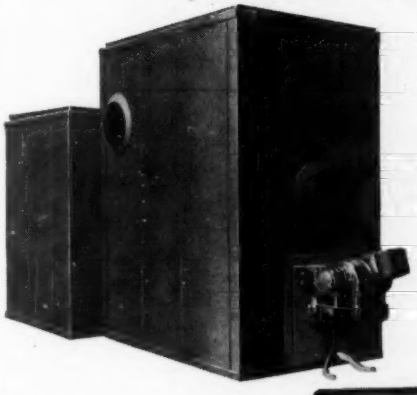

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According to an investigation of carbon monoxide concentrations in German coke plants and foundries employing a large work force, "chronic CO poisoning does not exist." It was recommended that the expert must decide the question of what CO concentrations in blood and air, in relation to time, can lead to subjective and objective symptoms related to CO. So called chronic CO poisoning was replaced by a concept of "mild, relapsing CO poisoning." Source: page 133 of abstracts of 13th International Congress On Occupational Health.

PROFESSIONAL SERVICES

LAUREN B. HITCHCOCK ASSOCIATES
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